

Massif; they probably were emplaced on the rim of Nansen crater by deposition of the light mantle.

*Petrographic descriptions:*

72735, metaclastic rock with an aphanitic matrix. Plagioclase and olivine (?) mineral clasts, no lithic clasts.

72736, metanorite (?) with clasts of norite (?) in a fine-grained poikilitic (?) matrix.

72738, polymict (?) breccia with clasts of finegrained metaclastic rock in an aphanitic matrix.

**STATION 2A (LRV -4)**

LOCATION

Station 2a is located on the light mantle about 600 m northeast of Nansen crater (fig. 7B).

OBJECTIVES

Station 2a was originally planned as an LRV sample stop to sample the light mantle; it was decided during the mission to add a traverse gravimeter reading, which permitted more comprehensive sampling than at a normal LRV sample stop.

GENERAL OBSERVATIONS

The station area is flat to gently rolling with scattered craters up to about 5 m in diameter. Most of the craters are subdued or have only slightly raised rims. None have blocky ejecta, but most have clods of "instant rock" (figs. 94, 95). The crew described the intercrater surface as blue-gray material overlying lighter colored material. The surface is saturated with small-craters up to 5 cm in diameter.

Rock fragments up to several centimeters in diameter cover less than one percent of the surface. Many appear to be only slightly buried, and fillets are poorly



FIGURE 92.-Photomosaic of second rake area at station 2 showing areas from which samples 72700-05 and 72735-38 were collected, before sampling. (NASA photographs AS 17-137-20974 and 20975.)

developed.

Samples include two surface sediment samples, a sediment sample from a depth of 15 cm in a trench, a clod that came from a crater wall and disintegrated to loose sediment by the time it reached the LRL, two breccia fragments from the surface, and two more breccia fragments from the trench.

GEOLOGIC DISCUSSION

The light mantle is interpreted as South Massif regolith, material transported to the valley floor either as an avalanche (Scott and Carr, 1972; Howard, 1973; Muehlberger and others, 1973) that may have been triggered by impacting secondary projectiles from Tycho, or as the ejecta of the secondary craters themselves (Lucchitta, 1977). The hypothesis that the light mantle formed from South Massif regolith is supported by (1) the predominance of fine-grained material and near-absence in the light mantle of cobble- and boulder-size fragments, reported by the crew and shown in figures 94 through 96, (2) the predominance of breccia fragments and near-absence of basalt in the samples, and (3) the obvious highlands provenance shown in the chemical composition of the sediment samples (fig. 93).

SUMMARY OF SAMPLING

Sample 73120-24

*Type:* Sedimentary, unconsolidated.

*Weight:* 287.68 g

*Depth:* From upper few centimeters.

*Location:* On light mantle at station 2a.

*Illustrations:* Figure 94.

*Comments:* Light mantle material.

*Petrographic description:* 73120-24, dominantly breccia and agglutinate.

*Components 90-150-um fraction of 73121.10 (Heiken and McKay, 1974)*

Components	Volume Percent
Agglutinate.....	41.7
Basalt, equigranular.....	--
Basalt, variolitic.....	--
Breccia:	
Low grade <sup>1</sup> - brown.....	8.7
Low grade <sup>1</sup> - colorless.....	7.7
Medium to high grade <sup>2</sup> .....	15.6
Anorthosite.....	.3
Cataclastic anorthosite <sup>3</sup> .....	1.0
Norite.....	.3
Gabbro.....	--
Plagioclase.....	8.3
Clinopyroxene.....	4.3
Orthopyroxene.....	2.3
Olivine.....	1.0
Ilmenite.....	2.0
Glass:	
Orange.....	1.7
"Black".....	.7
Colorless.....	2.3
Brown.....	2.0

Components of 90-150- $\mu$ m fraction of 73121,10 (Heiken and McKay, 1974)-Continued

Glass-continued	
Gray, "ropy".....	--
Other.....	--
Total number of grains.....	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

Major- element composition:

Chemical analyses of 73121

	1	2	3	4
SiO <sub>2</sub> .....	44.60	45.56	45.6	45.3
Al <sub>2</sub> O <sub>3</sub> .....	20.83	21.23	20.8	21.0
FeO.....	8.59	8.45	8.58	8.54
MgO.....	10.00	9.73	10.18	9.97
CaO.....	12.87	12.82	13.2	13.0
Na <sub>2</sub> O.....	.44	.39	.427	.42
K <sub>2</sub> O.....	.15	.17	.141	.15
TiO <sub>2</sub> .....	1.42	1.39	1.38	1.40
P <sub>2</sub> O <sub>5</sub> .....	.13	.15	.135	.14
MnO.....	.13	.11	.109	.12
Cr <sub>2</sub> O <sub>3</sub> .....	.22	.26	.210	.23
Total	99.38	100.26	100.762	100.27

1. 73121, 6 (Rhodes and others, 1974).
2. 73121, 16 (Rose and others, 1974).
3. 73121, 18 (Wanke and others, 1974).
4. Average of 1 through 3.

Sample 73130-34

Type: Sedimentary, unconsolidated

Weight: 238.07 g.

Depth: Disintegrated surface fragment.

Location: Collected about 30 cm down from rim -on wall of 2-m crater at station 2a.

Illustrations Figures 94, 95.

Comments: Collected as "instant rock" sample, but disintegrated in transit to the LRL.

Petrographic description: 73130-34, dominantly breccia.

Exposure age: <sup>22</sup>Na-<sup>26</sup>Al: 73131, minimum, 0.1 m.y.; maximum, 0.5±0.1 m.y. May limit age of the small fresh crater (Yokoyama and others, 1976).

Sample 73140-46

Type: Sedimentary, unconsolidated (73140-44) and two breccia fragments (73145, 73146).

Size: 73145, 2.5X2X1 cm.

Weight: 73140-44, 337.0 g; 73145, 5.6 g; 73146, 3.01 g.

Depth: 15 cm below surface.

Location: From bottom of trench at Station 2a.

Illustrations: Figure 94.

Comments: May be most representative of light mantle

material because of the absence of nearby large craters, distance from South Massif, and location from below surface.

Petrographic descriptions:

73140-44, dominantly fine-grained breccia and (or) metaclastic rock, some agglutinate:

Components of 90-150- $\mu$ m fraction of 73141,4 (Heiken and McKay, 1974)

Components	Volume Percent
Agglutinate.....	41.7
Basalt, equigranular.....	1.3
Basalt, variolitic.....	1.3
Breccia:	
Low grade <sup>1</sup> - brown.....	9.3
Low grade <sup>1</sup> - colorless.....	6.3
Medium to high grade <sup>2</sup> .....	19.3
Anorthosite.....	1.0
Cataclastic anorthosite <sup>3</sup> .....	1.3
Norite.....	.7
Gabbro.....	--
Plagioclase.....	6.7
Clinopyroxene.....	3.0
Orthopyroxene.....	3.3
Olivine.....	.7
Ilmenite.....	.3
Glass:	
Orange.....	.3
"Black".....	.3
Colorless.....	1.3
Brown.....	1.0
Gray, "ropy".....	.3
Other.....	--
Total number of grains.....	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

73145, metagabbroid (?) breccia with abundant plagioclase debris in an aphanitic matrix.

Major-element composition:

Chemical analyses of 73141

	1	2	3	4	5
SiO <sub>2</sub> .....	45.06	44.91	45.35	45.8	45.3
Al <sub>2</sub> O <sub>3</sub> .....	21.52	21.42	21.56	21.2	21.4
FeO.....	8.10	8.14	8.02	8.12	8.10
MgO.....	10.04	9.94	10.28	10.10	10.09
CaO.....	13.04	13.06	12.91	12.9	13.0
Na <sub>2</sub> O.....	.38	.44	.35	.431	.41
K <sub>2</sub> O.....	.15	.15	.14	.134	.14
TiO <sub>2</sub> .....	1.29	1.24	1.26	1.23	1.26
P <sub>2</sub> O <sub>5</sub> .....	.12	.12	.12	.119	.12
MnO.....	.11	.12	.11	.108	.11
Cr <sub>2</sub> O <sub>3</sub> .....	.21	.21	.24	.213	.22
Total	100.02	99.75	100.37	100.355	100.15

1. 73141,1 (Rhodes and others, 1974).
2. 73141,7 (Rhodes and others, 1974).
3. 73141,21 (Rose and others, 1974).
4. 73141,23 (Wanke and others, 1974).
5. Average of 1 through 4.

Sample 73150-56

Type: Sedimentary, unconsolidated (73150-54); polymict breccia with a cataclastic matrix (73155); and small breccia fragment (73156).

Size: 73155, 5.5 x4.2 x3.8 cm; 73156,1.5x1x1 cm.

Weight: 73150-54,158.95 g; 73155, 79.3 g; 73156, 3.15 g.

Depth: 0-1 cm.

Location: On surface of light mantle at station 2a.

Illustrations: Figures 96, 97 (LRL).

*Comments:* Sediment (73150-54) including a small breccia fragment (73156) scooped up with sample 73155.

*Petrographic descriptions:*

73150-54, dominantly fine-grained breccia and (or) metaclastic rock, some agglutinate.

73155, polymict breccia with fine-grained metaclastic clasts with variable proportions of minerals in an aphanitic matrix. This matrix has been locally shattered and invaded by coarser feldspathic debris.

**STATION 3**

**LOCATION**

Station 3 is located on the light mantle approximately

50 m east of the rim of Lara crater and just above the base of the Lee-Lincoln scarp (fig.7A).

**OBJECTIVES**

Analysis of orbital photographs before the mission indicated that the light mantle covered the scarp, which is probably the topographic expression of a fault upthrown on the west (Lucchitta, 1976). It was hoped that depositional structures indicative of the mode of origin might be seen where the light mantle was draped over the earlier formed scarp. Observation and sampling were planned to determine the interrelations and chronology of the scarp and light-mantle materials and to sample the light mantle near the base of the scarp.

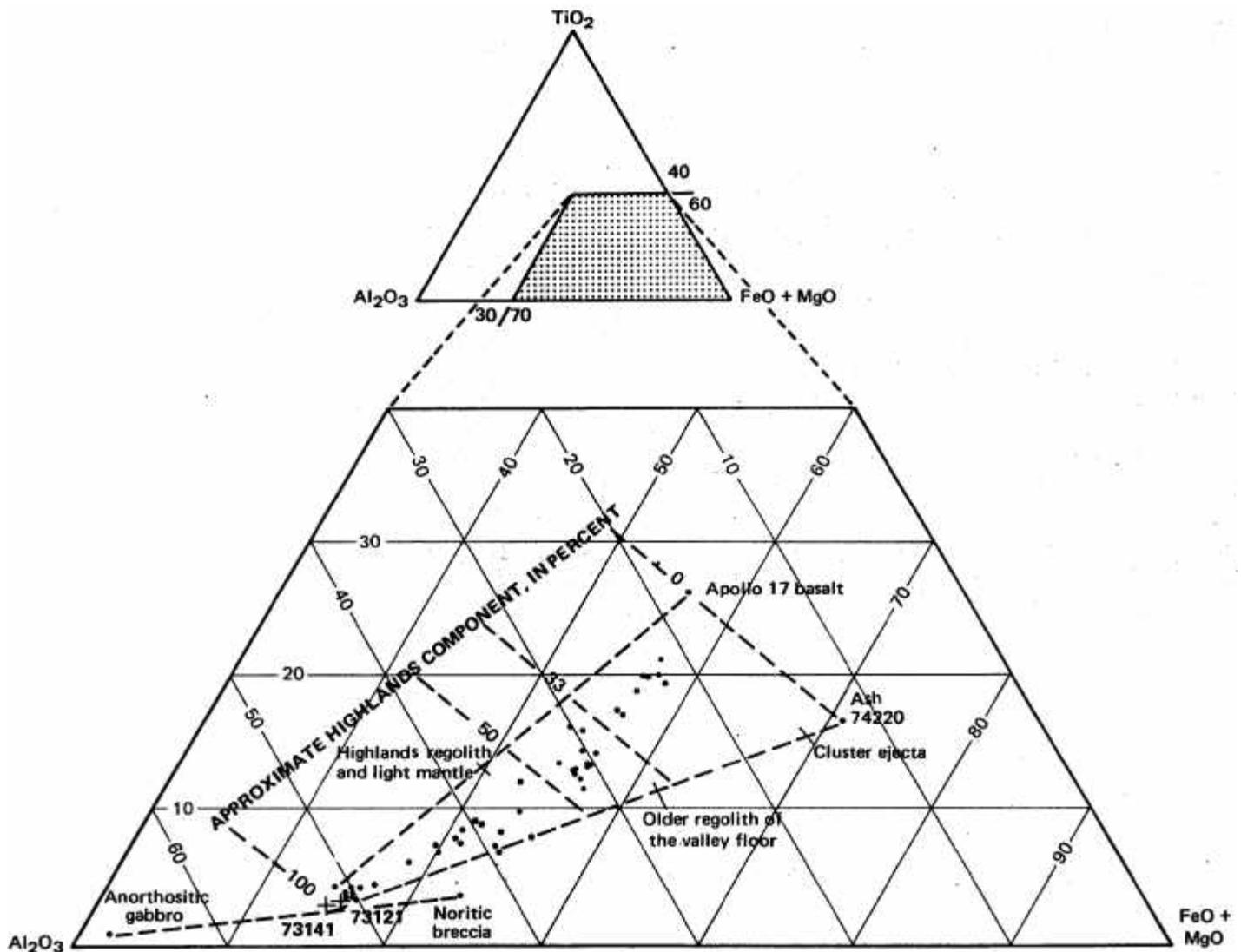


FIGURE 93.-Relative amounts of TiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, and FeO+MgO in sediment samples 73121 and 73141 (crosses), collected at station 2a, in comparison with sediment samples from rest of traverse region (dots). Apollo 17 basalt, anorthositic gabbro, and noritic breccia values from Rhodes and others (1974).

GENERAL OBSERVATIONS

The station area is on a northeast-facing slope of the scarp, which the crew had described earlier as being a series of hummocky lobes with north-south trends where the scarp crosses the light-mantle area.

Craters ranging in size from 4 cm to 15 m are common in the station area (pan 16). Those less than 2

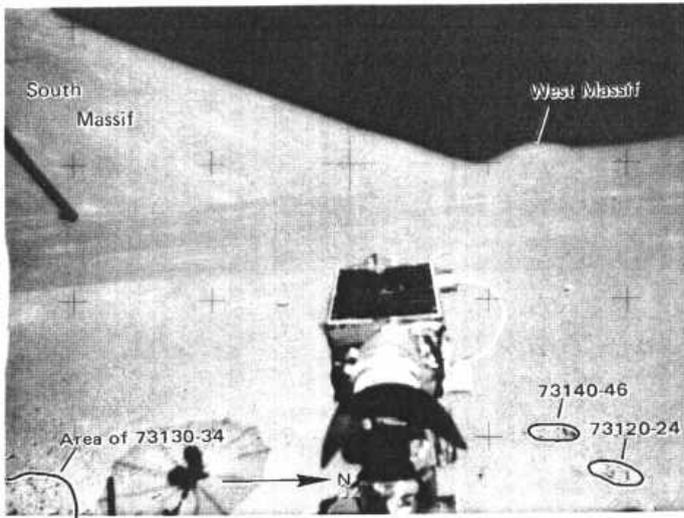


FIGURE 94.-Area of station 2a, from LRV, after samples 73120-24, 73130-34, and 73140-46 were collected. (NASA photograph AS17-138-21103.)

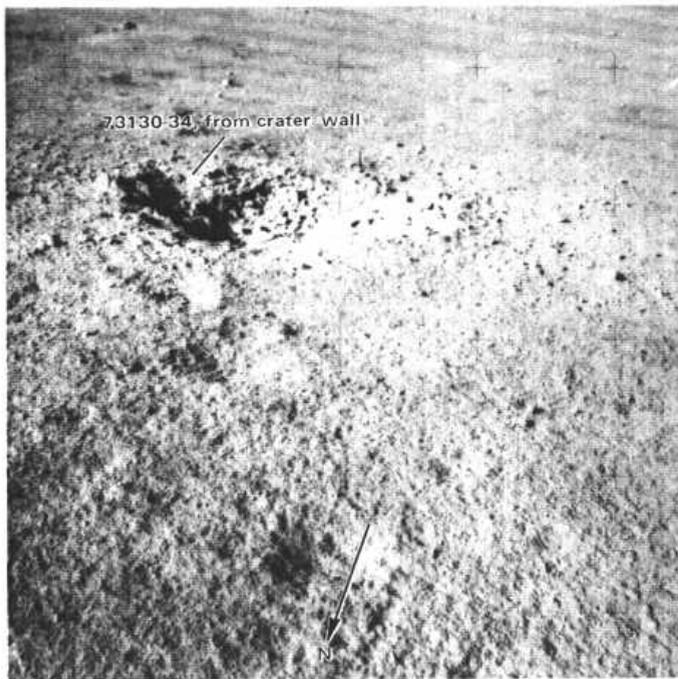


FIGURE 95.-The 2-m crater from which sample 73130-34 at station 2a was collected, before sampling. (NASA photograph AS 17-138-21097.)

m in diameter appear to be subdued and shallow; some have cloddy ejecta. Several of the craters larger than 2 m in diameter have blocky raised rims. The largest crater in the area is the 500-m Lara crater, which is covered by light mantle.

Rock fragments up to 25 cm across are common but cover less than 1 percent of the surface. Boulders up to 1 m across appear to be concentrated on and near the rims of the larger craters. Most of the rock fragments and boulders are perched on the surface or are only slightly buried. Fillets are poorly developed.

The surface sediment was described as medium gray in color. Footprints and LRV tracks in the photographs of the station area reveal lighter gray material just below the surface. A shallow trench showed that medium-gray surface material about 0.5 cm thick overlies a light-gray layer 3 cm thick, which in turn overlies marbled or mottled light- and medium-gray material.

Samples at station 3 consisted of a double drive tube, eight rock samples, and five sediment samples, four of which were collected from a trench (fig. 98). All of the samples except the drive tube were collected from the raised rim of a 10-m crater. The drive tube was taken near the base of the scarp, about 20 m south-southeast of the 10-m crater.

GEOLOGIC DISCUSSION

Except for one small fragment of olivine basalt (sample 73219), rocks collected at station 3 are breccias presumably transported from the surface of the South Massif during emplacement of the light mantle. Only one rock, polymict breccia sample 73215, has been studied in detail (James consortium; see discussion of 73215 for citations). It consists of flow-banded dark aphanite and lighter colored granulated elastic debris. The aphanite has been interpreted by the consortium as laden melt assembled in a basin-forming impact; flow banding was produced during transport of the ejecta from the transient cavity.

In preliminary examination (Wilshire, this report), polymict breccia 73235 resembled 73215. Major-element data for the two rocks (fig. 99) show that they are very much alike and that they fall within the narrow compositional spectrum of the Apollo 17 highlands materials.

The station 3 samples came largely from near the rim crest of a 10-m crater, which apparently penetrated only light-mantle material. Sediment samples from the trench dug in the crater rim show chemically (fig. 100) and petrographically the preponderance of highlands material and the near absence of admixed basaltic debris. Measurements of <sup>22</sup>Na and <sup>26</sup>Al in the four trench samples (73231, 73241, 73261, 73281) suggest that the 10-m crater may have formed within the last 2 m.y. (Yokoyama and others, 1976). Alternately, the track age of 4.7±1 m.y. determined for 73275 could repre-

sent the age of the small crater (Croaz and others, 1974 ).

Rocks from station 3 record a complex range of noble-gas exposure ages, all older than 100 m.y. These ages presumably reflect exposure that occurred either (1) in the regolith of the South Massif before the light mantle was deposited or (2) in the light mantle since its emplacement on the valley floor.

SUMMARY OF SAMPLING  
Sample 73002 / 73001 (upper / lower)

*Type:* Double drive tube.

*Length:* 56.9 cm (73001, 34.9 cm; 73002, 22.0 cm).

*Depth:* Approximately 70.6 cm.

*Weight:* 1,238.7 g (73001, 809 g; 73002, 429.7 g).

*Location:* On light mantle near base of scarp.

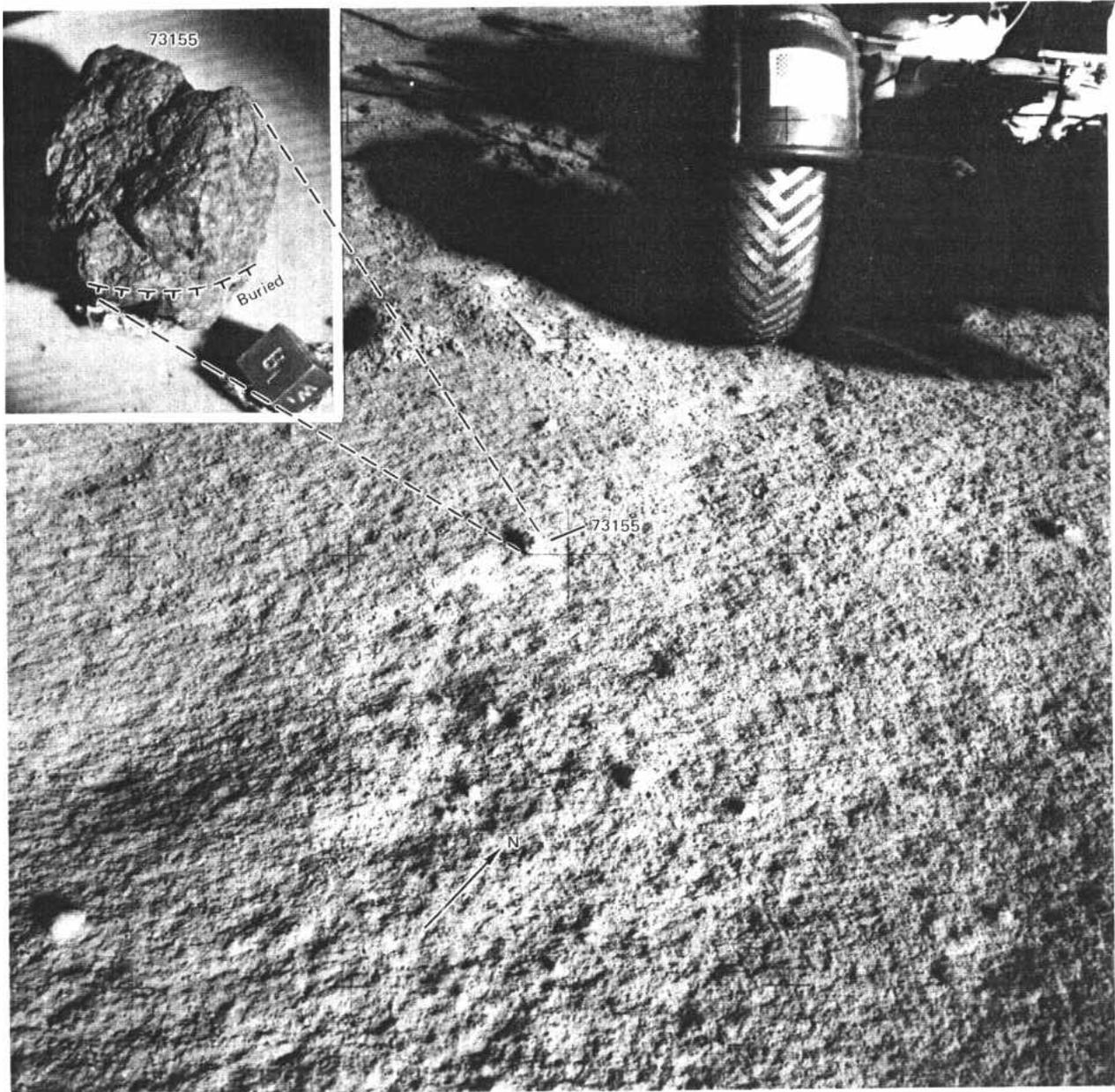


FIGURE 96.-Location of sample 73155 before collection. Sediment sample 73150-54, including small fragment 73156, was scooped up with 73155. Inset shows 73155 with reconstructed lunar surface orientation and lighting. (NASA photographs AS17-138-21099; S-73-19595.)

*Illustrations:* Pan 16; figure 101.

*Comments:* Light mantle material apparently undisturbed by recent cratering. About 4 cm of sample was spilled from the bottom of the upper drive tube (73002).

Sample 73210-14

*Type:* Sedimentary, unconsolidated.

*Weight:* 98.58 g

*Depth:* From surface.

*Location:* From rim of 10-m crater at station 3.

*Illustrations:* Pan 16; figures 102,103.

*Comments:* Surface sediment collected with five rock fragments (73215-19).

*Petrographic description:* 73210-14, dominantly breccia.

Sample 73215

*Type:* Polymict breccia with a cataclastic matrix.

*Size:* 12x11x8.5 cm.

*Weight:* 1,062 g.

*Location:* From rim of 10-m crater at station 3.

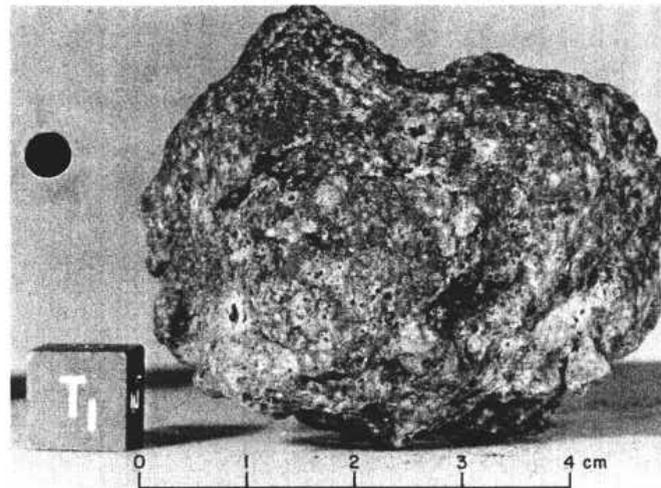


FIGURE 97.-Sample 73155. Polymict breccia with locally cataclastic matrix. (NASA photograph S-73-17056.)

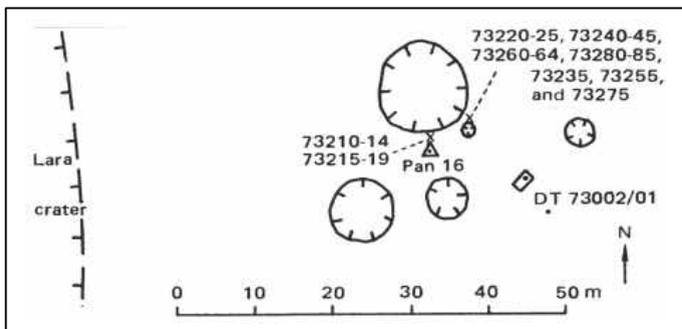


FIGURE 98.-Planimetric map of station 3.

*Illustrations:* Pan 16; figures 102, 103, 104 (LRL), 105 (photomicrograph).

*Comments:* Light-gray breccia, probably from the South Massif.

*Petrographic description:* Polymict breccia with crudely banded light and dark clastic material; light material (weakly annealed?) injected into broken dark polymict breccia. Light material is coarse metaclastic debris derived from troctolite or metatroctolite and other sources. In the dark breccia, clasts in the size range 0.1 to 1.0 mm are in the following approximate proportions: 52 percent plagioclase, 4 percent pyroxene, 1 percent pink spinel, 19 percent olivine, 4 percent light metaclastic rocks, 11 percent dark metaclastic rocks, 2 percent recrystallized olivine, 10 percent recrystallized plagioclase.

Sample 73215 has been studied by a consortium whose major petrographic and petrologic conclusions (James, 1975, 1976a, b; James and others, 1975a, b, 1976; James and Blanchard, 1976) are:

(1) The rock consists of subparallel bands of different types of aphanite interspersed with bands of granulated clastic material; this fabric was produced by flow of the constituents during aggregation. Flow and subsequent shearing also formed small faults at high angles to the banding, small schlieren derived from granulated clasts, and several sets of finely spaced fractures.

(2) The bulk of 73215 is gray to black aphanite that occurs not only as "matrix" but as clasts within aphanite matrix and within zones of granulated clastic material. The aphanite, considered equivalent to the gray and black competent breccias of boulder 1 at station 2, is an aggregate of mineral (mainly plagioclase, olivine, pyroxene) and lithic (dominated by anorthosite-norite-troctolite suite) clasts enclosed in a very fine groundmass. The groundmass, interpreted as having crystallized from a melt, is described as micro intergranular to microsubophitic; most grains are 1-8 um in size. Dominant constituents are plagioclase and low-calcium pyroxene, with minor amounts of olivine, opaque minerals, iron metal, and troilite. As shown by microprobe analyses (not given in this report), the groundmass is less rich in CaO and Al<sub>2</sub>O<sub>3</sub> (that is, more mafic) than is the bulk aphanite; hence, the presumed melt from which it crystallized was not simply derived by melting of the clast suite it contains.

(3) Melt and clasts, now aggregated as the aphanite, presumably were produced and violently mixed in a basin-forming impact. The clasts represent rock crushed within and beneath the growing crater cavity and ejected along with melt (now the very fine groundmass) generated in the same impact. Most

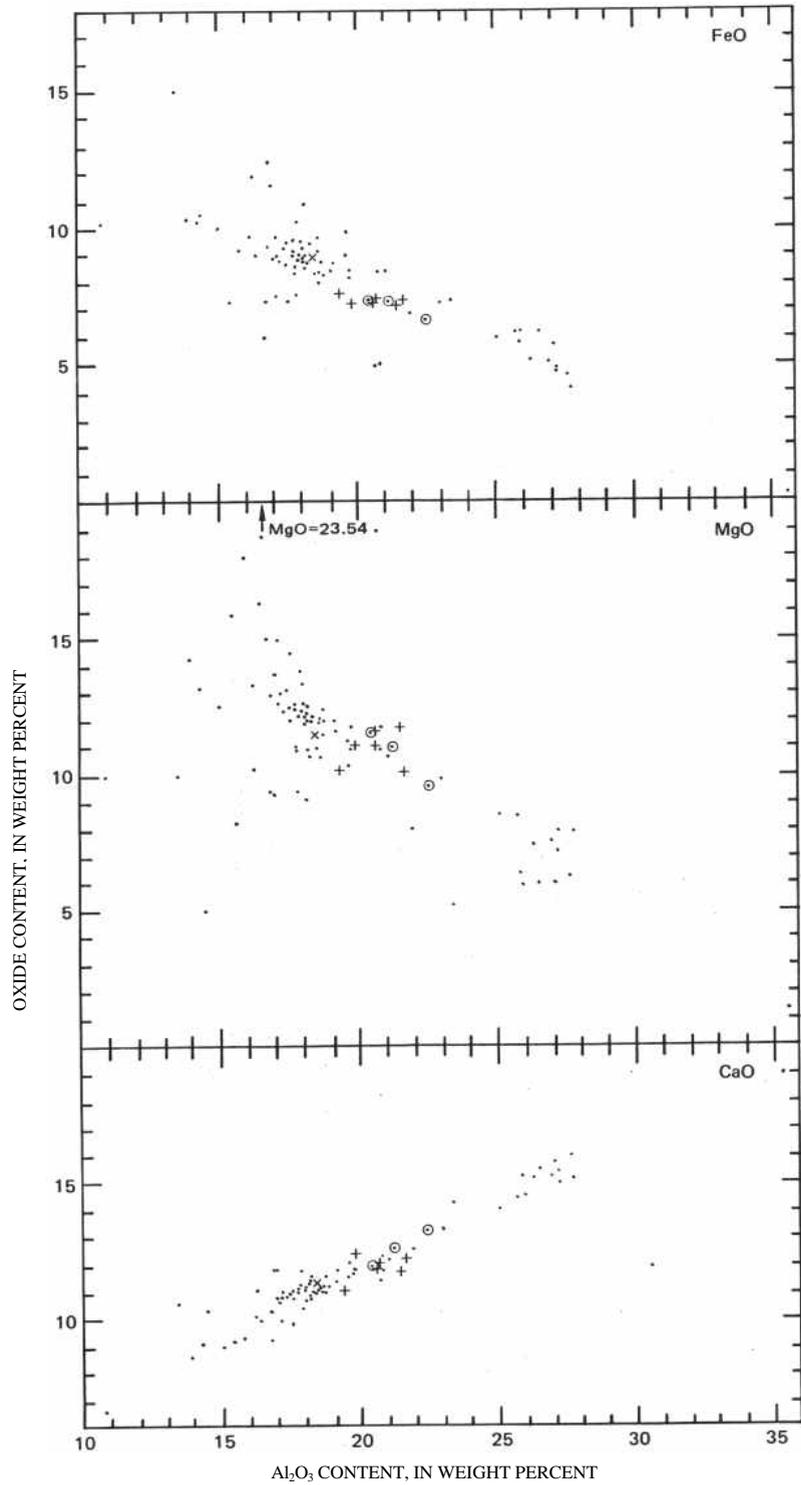


FIGURE 99.-Plots of FeO, MgO, and CaO contents in relation to  $Al_2O_3$  content for analyzed rocks from station 3 in comparison with all analyzed Apollo 17 highlands rocks (dots). Cross, 73215 aphanitic "matrix;" circled dot, 73235; X, 73275.

clasts were not strongly shocked or heated in the impact but some had been shocked, and some were at high temperatures. The melt cooled rapidly and crystallized as it was mixed with the relatively cold clasts. Lithologic banding, schlieren, and preferred orientation of elongate clasts were produced by flow during aggregation of the breccia.

Major- element composition:

*Chemical analyses of aphanite "matrix" from 73215*

	1	2	3	4	5	6
SiO <sub>2</sub> .....	46.1	48.1	46.1	46.8	46.4	45.9
Al <sub>2</sub> O <sub>3</sub> .....	21.7	19.4	19.9	21.5	20.7	20.6
FeO.....	7.39	7.64	7.28	7.2	7.43	7.34
MgO.....	10.2	10.2	11.1	11.8	11.1	11.6
CaO.....	12.2	11.0	12.3	11.8	12.0	11.8

*Chemical analyses of aphanite "matrix" from 73215-Continued*

	1	2	3	4	5	6
Na <sub>2</sub> O.....	.495	.624	.487	.488	.520	.52
K <sub>2</sub> O.....	.167	.656	.191	.170	.273	.205
TiO <sub>2</sub> .....	1.1	.8	1.1	.4	.81	.7
P <sub>2</sub> O <sub>5</sub> .....	--	--	--	--	--	--
MnO.....	.104	.123	.119	.099	.107	.104
Cr <sub>2</sub> O <sub>3</sub> .....	.200	.168	.221	.230	.211	.250
Total	99.7	98.7	98.8	100.4	99.6	99.0

1. 73215.74 homogeneous gray matrix (James and others, 1975a).
2. 73215.161 homogeneous black matrix (James and others, 1975a).
3. 73215.177 schlieren-rich gray matrix (James and others, 1975a).
4. 73215.184 heterogeneous black matrix (James and others, 1975a).
5. 73215 average of eight typical matrix samples (James and others, 1975b).
6. 73215 average of matrix samples 73215.74; 151; 170B; 177; 184; 159; 185; 209; 262 (James and others, 1976).

Age:

Fission track: Whitlockite crystal 4.05 +0.05/-0.08 b.y.,  
(Braddy and others, 1975).

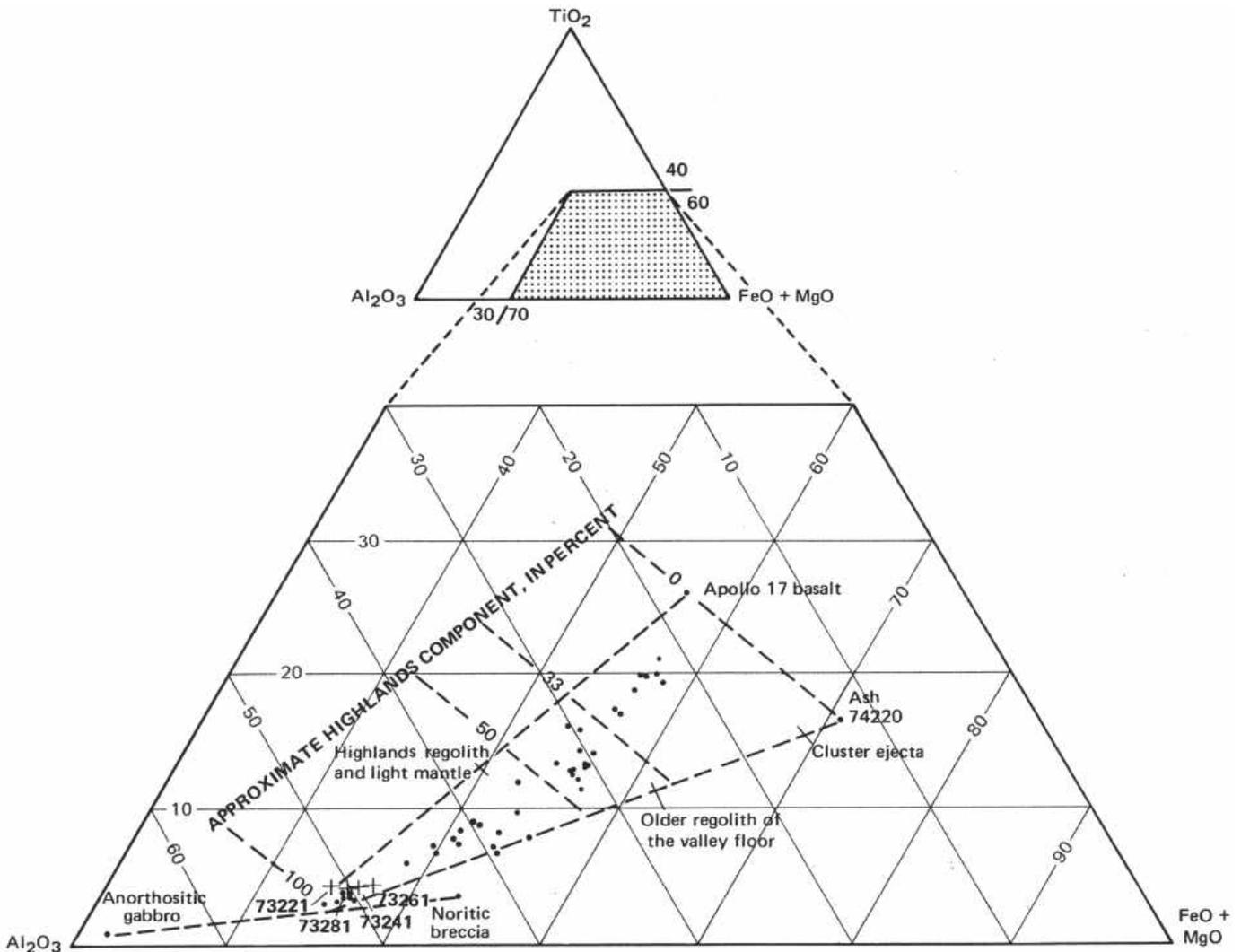


FIGURE 100.-Relative amounts of TiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, and FeO+MgO in sediment samples 73221, 73241, 73261, and 73281 from trench at station 3 (crosses) in comparison with sediment samples from rest of traverse region (dots). Apollo 17 basalt, anorthositic gabbro, and noritic breccia values from Rhodes and others (1974).

Compaction age: tracks in plagioclase crystal from radioactive decay in adjacent groundmass -  $4.08 \pm 0.07 / -0.2$  b.y. (Goswami and others, 1976b).

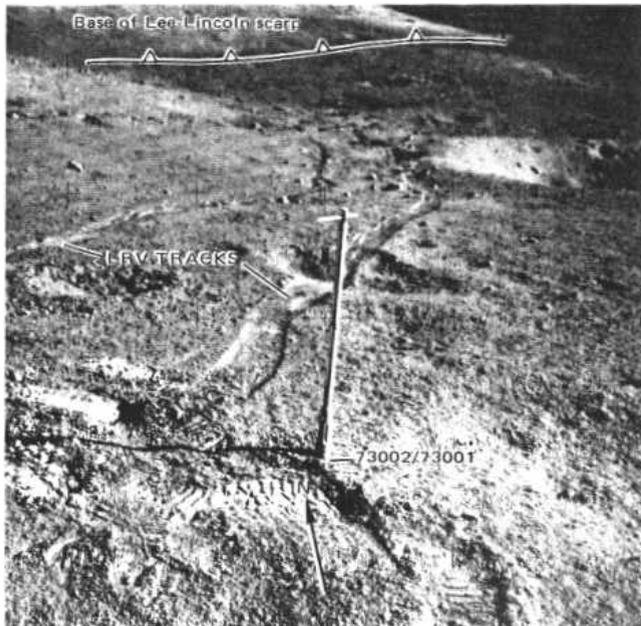


FIGURE 101.-Drive-tube sample 73002/73001 during sampling. (NASA photograph AS17-137-20981.)

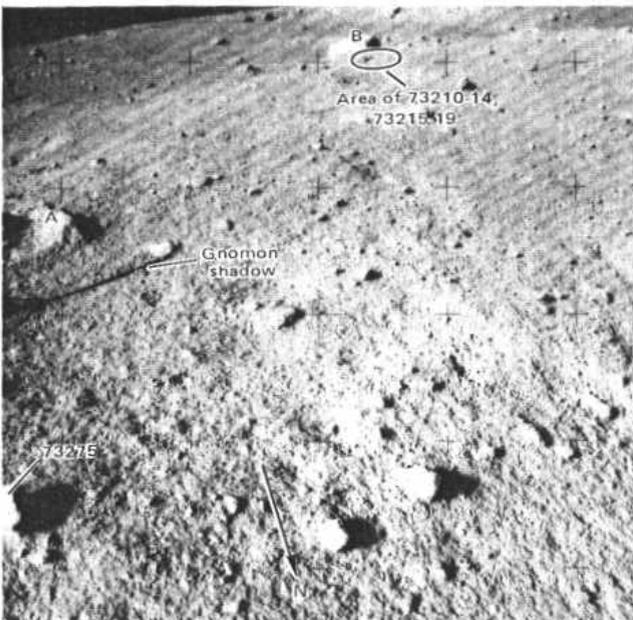


FIGURE 102.-Locations of samples 73210-14, 15-19, and 73275, before collection. Letters A and B indicate same boulders seen in figures 103, 109, and 110. (NASA photograph AS 17-138-21145.)

Pb-U-Th data suggest that 73215 matrix was strongly modified by extensive outgassing of Pb approximately 4.0 b.y. ago (James and others, 1975a).

<sup>40-39</sup>Ar (Jessberger and others, 1976b):

- 73215, 41.1, black matrix,  $4.04 \pm 0.03$  b.y.
- 73215, 73.1, gray matrix,  $4.15 \pm 0.01$  b.y.
- 73215, 177.1, schlieren-rich gray matrix,  $4.13 \pm 0.04$  b.y.
- 73215, 38.57, gray aphanite spheroid,  $4.16 \pm 0.03$  b.y.
- 73215, 46, 10, 7, black aphanite clast,  $4.24 \pm 0.01$  b.y.
- 73215, 46, 6, 1, dark-gray aphanitic clast,  $4.17 \pm 0.07$  b.y.
- 73215, 38, 39, 1, 2, feldspathic clast,  $4.11 \pm 0.05$  b.y.,  $4.28 \pm 0.03$  b.y.
- 73215, 38, 39, 1, 1, troctolite vein,  $4.00 \pm 0.06$  b.y.
- 73215, 29, 9, 6, anorthositic gabbro clast,  $4.061.02$  b.y.,  $4.24 \pm 0.01$  b.y.
- 73215, 46, 25, 5, anorthositic gabbro clast,  $4.07 \pm 0.01$  b.y.,  $4.26 \pm 0.01$  b.y.
- 73215, 46, 33, 4, anorthositic gabbro clast,  $4.07 \pm 0.01$  b.y.,  $4.22 \pm 0.01$  b.y.

An age of  $\sim 4.05$  b.y. is interpreted as an older limit on the event that aggregated the aphanite "matrix," because the abundant small clasts presumably were incom-



FIGURE 103.-Area of samples 73210-14 and 15-19 after collection, and the eastern part of the 10-m crater at station 3. Scoop and sample collection bag at right. B refers to boulder seen in figures 102 and 110. (NASA photograph AS 17-138-21160.)

pletely outgassed. An age of ~4.25 b.y. is interpreted as a younger limit for the age of crystallization or metamorphism of preimpact rocks of the target, because they probably were partially outgassed during formation of the 73215 breccia (Jessberger and others, 1976b).

Rb-Sr isochron: anorthositic gabbro, 4.24+/-0.31 (2σ) b.y. Age is interpreted as a younger limit for crystallization of the anorthositic gabbro parent rock (James and others, 1976a).

*Exposure age:*

Kr: 243±7 m.y. (matrix) (James and others, 1975a).

Ar: (Jessberger and others, 1976b):

73215, 41.1, black matrix, 254±9 m.y.

73215, 73.1, gray matrix, 238±12 m.y.

73215,177.1, schlieren-rich gray matrix, 257 ±11 m.y.

73215,38.57, gray aphanite spheroid, 259±12 m.y.

73215,46,10,7, black aphanite clast, 252±22 m.y.

73215,46,6,1, dark-gray aphanitic clast, 256±24 m.y.

73215, 38,39,1,2, feldspathic clast, 228±40 m.y.

73215,38,39,1,1, troctolite vein, 247±62 m.y.

73215,29,9,6, anorthositic gabbro clast, 268±6 m.y.

73215,46,25,5, anorthositic gabbro clast, 250±12 m.y.

73215,46,33,4, anorthositic gabbro clast, 244±10 m.y.

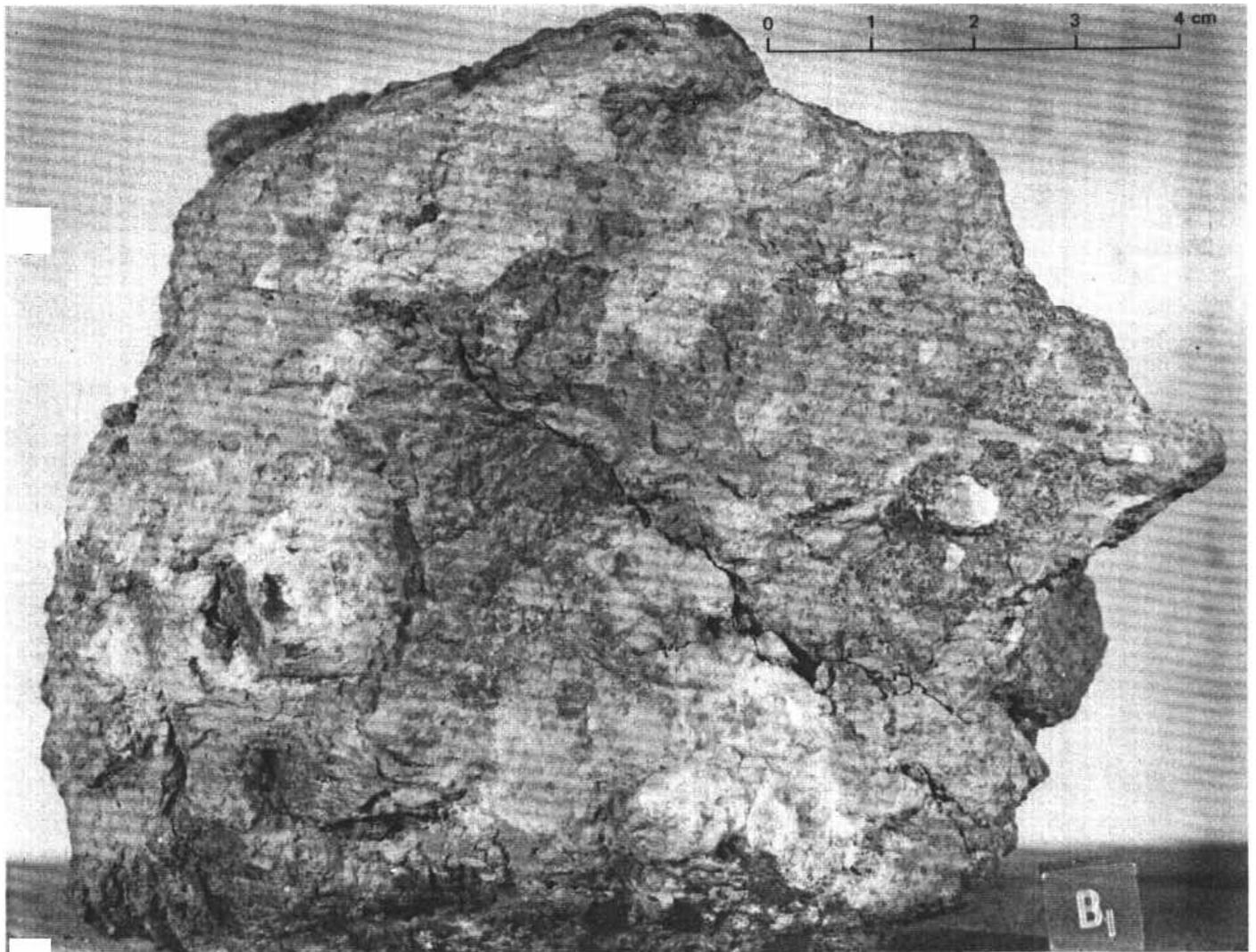


FIGURE 104.-Sample 73215. Polymict breccia with cataclastic matrix. (NASA photograph S-73-16663.)

Agreement of clast exposure ages with the Kr exposure age for the matrix is evidence against irradiation of clasts in the regolith before aggregation of the breccia (Jessberger and others, 1976a).

Sample 73216

*Type:* Polymict breccia with a granoblastic matrix.

*Size:* 7x5x3 cm.

*Weight:* 162.2 g.

*Location:* From rim of 10-m crater at station 3.

*Illustrations:* Pan 16; figures 102, 103, 106 (LRL).

*Comments:* Greenish-gray breccia, probably from the South Massif.

*Petrographic description:* Polymict breccia with clasts of metaclastic rock and feldspathic plutonic derivatives in a fine-grained granoblastic matrix. Moderately abundant plagioclase and olivine clasts.

Sample 73217

*Type:* Polymict breccia with an aphanitic matrix.

*Size:* 6.5x4.5x3.0 cm.

*Weight:* 138.8 g.

*Location:* From rim of 10-m crater at station 3.

*Illustrations:* Pan 16; figures 102, 103, 107 (LRL).

*Comments:* Blue-gray breccia, probably from the South Massif.

*Petrographic description:* Polymict breccia with clasts of dark metaclastic rock, light feldspathic cataclasite, and mineral debris (dominantly plagioclase) in an aphanitic matrix.

Sample 73218

*Type:* Polymict breccia with an aphanitic matrix.

*Size:* 4x3x2.5 cm.

*Weight:* 39.67 g.

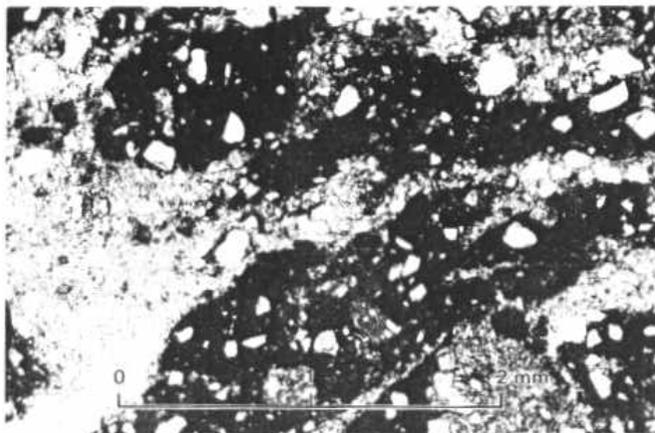


FIGURE 105.-Sample 73215. Photomicrograph showing clasts of polymict breccia with dark aphanitic matrices in matrix of fragmented feldspathic debris.

*Location:* From rim of 10-m crater at station 3.

*Illustrations:* Pan 16; figures 102, 103, 108 (LRL).

*Comments:* Greenish-gray breccia, probably from the South Massif.

*Petrographic description:* Polymict breccia with clasts of light metaclastic rock, metagabbroid rock, and plagioclase, pyroxene, and olivine mineral debris.

Sample 73219

*Type:* Olivine basalt.

*Size:* 1.5x1.3x1.0 cm.

*Weight:* 2.88 g.

*Location:* From rim of 10-m crater at station 3.

*Illustrations:* Pan 16; figures 102, 103.

*Comments:* Presumably subfloor basalt ejected from some distant crater.

Sample 73220-25

*Type:* Sedimentary, unconsolidated (73220-24), including rock fragment (73225).



FIGURE 106.-Sample 73216. Polymict breccia with granoblastic matrix. (NASA photograph S-73-16780.)

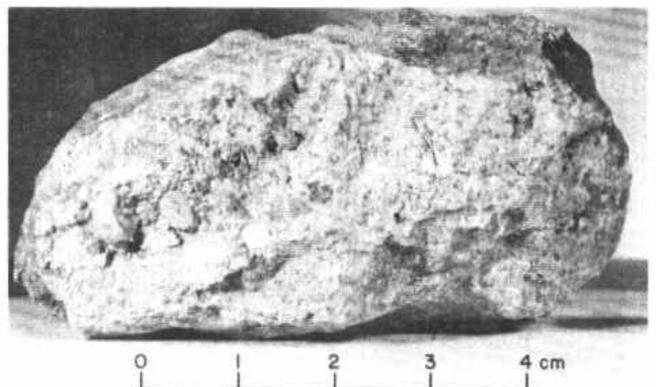


FIGURE 107.-Sample 73217. Polymict breccia with aphanitic matrix. (NASA photograph S-73-16785.)

Size: 73225, 1.7x1.5x1.3 cm.

Weight: 73220-24, 75.88 g; 73225, 3.66 g.

Depth: Upper one-half cm of trench wall.

Location: From trench on rim of 10-m crater at station 3.

Illustrations: Pan 16; figures 109, 111.

Comments: Ejecta from the 10-m crater.

Petrographic description: 73220-24, dominantly finegrained breccia and (or) metaclastic rock, some unannealed feldspar cataclasis, scarce glass.

Components of 90-150-um fraction of 73221, 1 (Heiken and McKay, 1974)

Components	Volume Percent
Agglutinate.....	26.3
Basalt, equigranular.....	3.0
Basalt, variolitic.....	3.0
Breccia:	
Low grade <sup>1</sup> - brown.....	18.3
Low grade <sup>1</sup> - colorless.....	10.3
Medium to high grade <sup>2</sup> .....	18.0
Anorthosite.....	.3
Cataclastic anorthosite <sup>3</sup> .....	.3
Norite.....	--
Gabbro.....	--
Plagioclase.....	11.3
Clinopyroxene.....	8.0
Orthopyroxene.....	Trace
Olivine.....	1.3
Ilmenite.....	.3
Glass:	
Orange.....	--
"Black".....	2.6
Colorless.....	.3
Brown.....	.6
Gray, "ropy".....	--
Other.....	--
Total number of grains.....	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

Major-element composition:

Chemical analyses of 73221

	1	2	3
SiO <sub>2</sub> .....	45.20	45.1	45.2
Al <sub>2</sub> O <sub>3</sub> .....	21.03	20.6	20.8
FeO.....	8.85	8.75	8.80
MgO.....	8.97	9.38	9.18
CaO.....	12.86	12.5	12.7
Na <sub>2</sub> O.....	.41	.461	.44
K <sub>2</sub> O.....	.16	.142	.15
TiO <sub>2</sub> .....	1.86	1.82	1.84
P <sub>2</sub> O <sub>5</sub> .....	.15	--	.15
MnO.....	.11	.116	.11
Cr <sub>2</sub> O <sub>3</sub> .....	.27	.219	.24
Total	99.87	99.088	99.61

1. 73221.13 (Rose and others, 1974).
2. 73221.16 (Wanke and others, 1974).
3. Average of 1 and 2.

Exposure age: <sup>22</sup>Na <sup>26</sup>Al: 73221, minimum 0.8±0.2 m.y.; maximum 1.1±0.2 m.y. (Yokoyama and others, 1976).

Sample 73235

Type: Polymict breccia with a cataclast is matrix.

Size: 12x10x8 cm.

Weight: 878.3 g.

Location: From surface on rim of 10-m crater at station 3.

Illustrations: Pan 16; figures 109, 110, 111, 112 (LRL), 113 (photomicrograph).

Comments: Ejecta from the 10-m crater.

Petrographic description: Polymict breccia with clasts of metagabbroid rocks, and plagioclase, pyroxene, arid olivine porphyroclasts in a dark aphanitic matrix. The matrix has been shattered and invaded by coarse angular fragments of minerals, mostly feldspar, and some brown spinel-plagioclase symplectite.

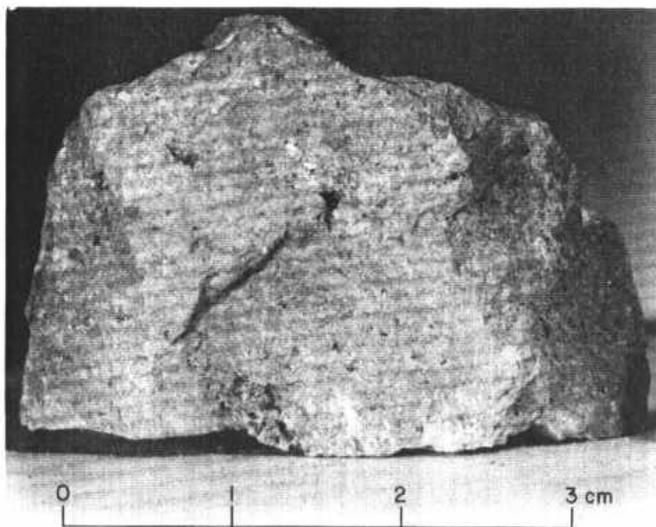


FIGURE 108.-Sample 73218. Polymict breccia with aphanitic matrix. (NASA photograph S-73-16911.)

Major-element composition:

Chemical analyses of 70011

	1	2	3
SiO <sub>2</sub> .....	41.96	46.20	46.6
Al <sub>2</sub> O <sub>3</sub> .....	22.57	21.28	20.50
FeO.....	6.68	7.32	7.38
MgO.....	9.61	11.05	11.54
CaO.....	13.18	12.55	11.9
Na <sub>2</sub> O.....	.44	.48	.456
K <sub>2</sub> O.....	.200	.20	.198
TiO <sub>2</sub> .....	.60	.67	.65
P <sub>2</sub> O <sub>5</sub> .....	.192	.20	.186
MnO.....	.091	.11	.100
Cr <sub>2</sub> O <sub>3</sub> .....	.196	--	.199
Total	99.719	100.06	99.67

1. 73235.53 (Duncan and others, 1974).
2. 73235.55 (Rhodes and others, 1974).
3. 73235.91 (Wanke and others, 1974).

Age: <sup>40-39</sup>Ar:  
73235, 3.96 +0.04/-0.08 b.y., (Turner and Cadogan, 1975).  
73235,27, 3.98±0.04 b.y., (Phinney and others, 1975).

Exposure age:  
Ar:  
111 m.y. (Arvidson and others, 1974) .  
110 m.y. (Turner and Cadogan, 1975).  
195±20 m.y. (Phinney and others, 1975).

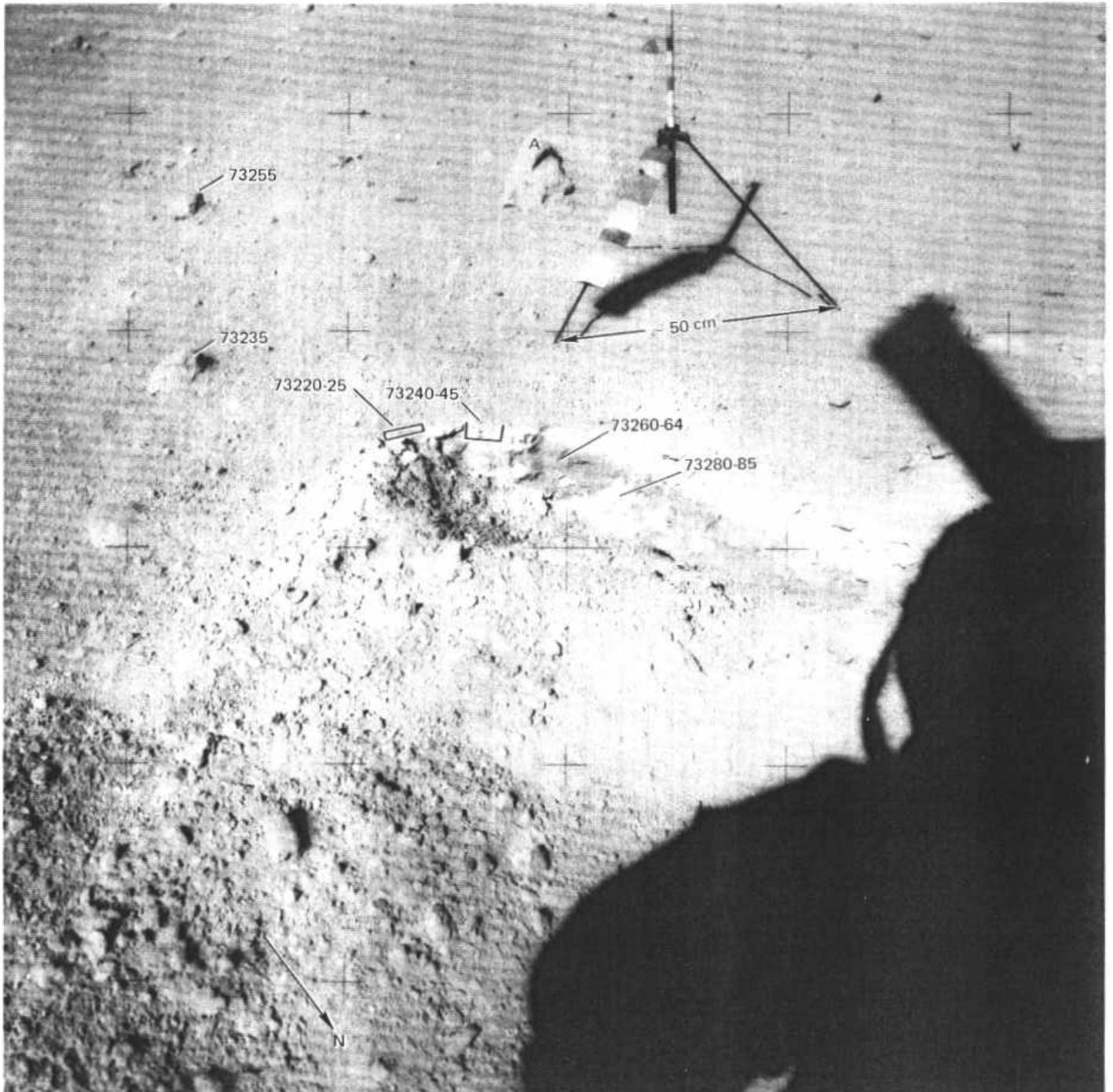


FIGURE 109.-Trench, 10-15 cm deep, at station 3, showing areas from which samples 73220-25, 73240-45, 73260-64, and 73280-85 were collected, before sampling. Samples 73235 and 73255 also shown. A designates boulder also seen in figures 102, 103, and 110. (NASA photograph AS17-138-21148.)

Sample 73240-45

Type: Sedimentary, unconsolidated (73240-44) and breccia fragment (73245).

Size: 73245, 1x1x0.8 cm.

Weight: 73240-44, 358.97 g; 73245, 1.6 g.

Depth: Upper 5 cm of soil in trench.

Location: From trench on rim of 10-m crater at station 3.

Illustrations: Pan 16; figures 109, 111.

Comments: Ejecta from 10-m crater.

Petrographic description: 73240-44, dominantly finegrained breccia and (or) metaclastic rock, some agglutinate.

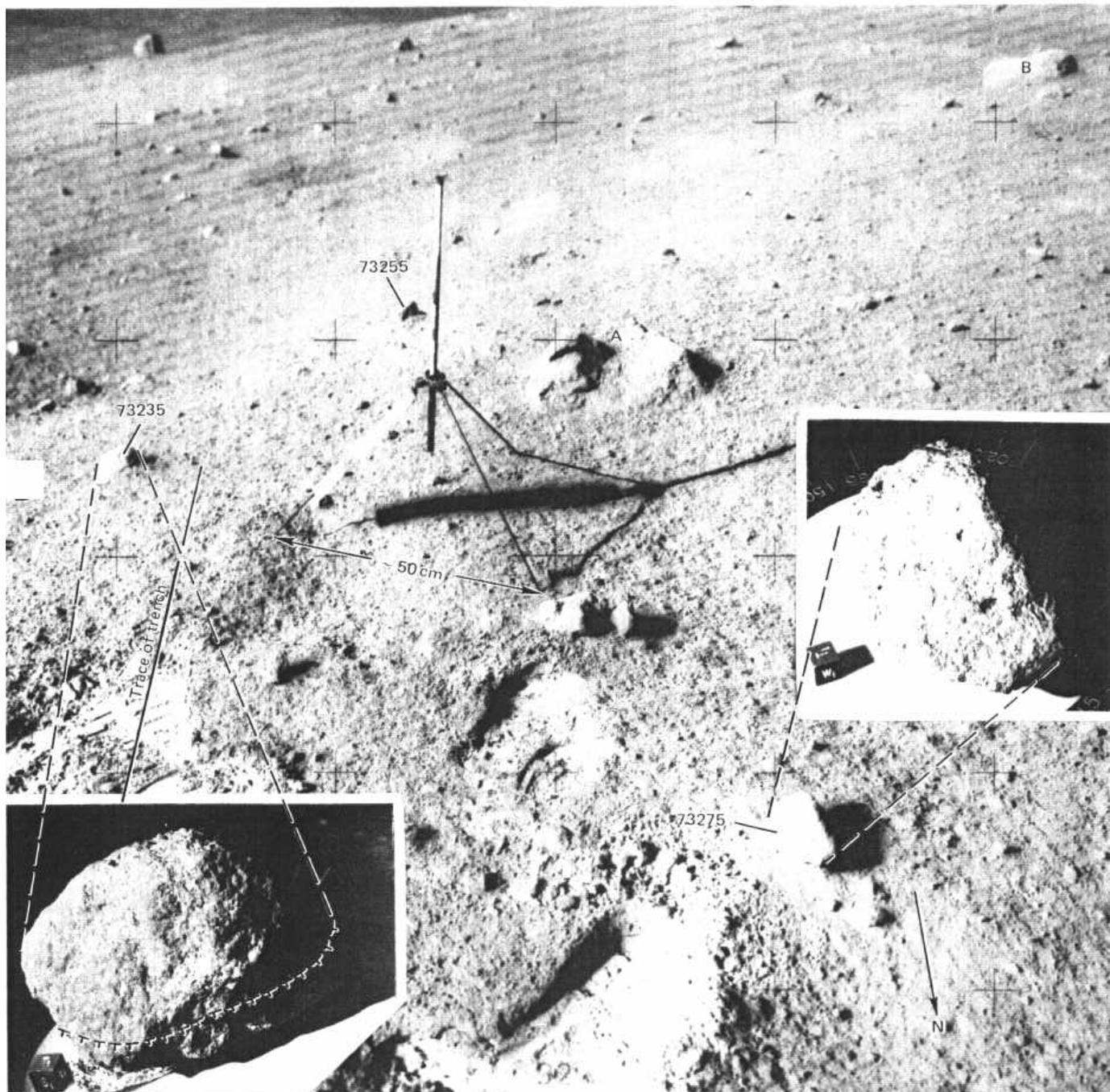


FIGURE 110.-Samples 73235, 73255, and 73275 before collection, and approximate trace of west edge of trench shown in figure 111. Insets show 73235 and 73275 with reconstructed lunar surface orientations and lighting. A and B designate boulders shown in figures 102, 103, and 109. (NASA photographs AS 17-138-21144; S-73-16968 (73235), S-73-16969 (73275).)

Components of 90-150- $\mu$ m fraction of 73241,9 (Heiken and McKaY, 1974)

Components	Volume Percent
Agglutinate.....	8.4
Basalt, equigranular.....	1.0
Basalt, variolitic.....	--
Breccia:	
Low grade <sup>1</sup> - brown.....	35.8
Low grade <sup>1</sup> - colorless.....	.3
Medium to high grade <sup>2</sup> .....	25.4
Anorthosite.....	.3
Cataclastic anorthosite <sup>3</sup> .....	2.7
Norite.....	--
Gabbro.....	--
Plagioclase.....	11.4
Clinopyroxene.....	3.3
Orthopyroxene.....	2.0
Olivine.....	.7
Ilmenite.....	--
Glass:	
Orange.....	.3
"Black".....	5.7
Colorless.....	1.0
Brown.....	--
Gray, "ropy".....	1.0
Other.....	--
<b>Total number of grains.....</b>	<b>299</b>

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

Major-element composition:

Chemical analyses of 73241

	1	2	3
SiO <sub>2</sub> .....	44.55	45.4	45.0
Al <sub>2</sub> O <sub>3</sub> .....	20.20	20.56	20.38
FeO.....	8.45	8.39	8.42
MgO.....	11.11	9.65	10.38
CaO.....	12.90	12.6	12.8
Na <sub>2</sub> O.....	.46	.448	.45
K <sub>2</sub> O.....	.16	.146	.15
TiO <sub>2</sub> .....	1.73	1.68	1.70
P <sub>2</sub> O <sub>5</sub> .....	.15	.126	.14
MnO.....	.11	.109	.11
Cr <sub>2</sub> O <sub>3</sub> .....	.25	.200	.22
<b>Total</b>	<b>100.07</b>	<b>99.309</b>	<b>99.75</b>

1. 73241,14 (Rose and others, 1974).
2. 73241,17 (Wanke and others, 1974).
3. Average of 1 and 2.

Exposure age:

<sup>22</sup>Na-<sup>26</sup>Al: 73241, minimum 0.6±0.6 m.y.; maximum 1.5±0.5 m.y. (Yokoyama and others, 1976).

Tracks: 85 percent of feldspar crystals have low track density; these crystals are interpreted as having had maximum exposure of 20 m.y. Hence, the 10-m crater is 20 m.y. old or less (Croaz and others, 1974).

Sample 73255

Type: Polymict breccia with an aphanitic matrix.

Size: 8x7.5x5 cm.

Weight: 394.1 g.

Location: From surface on rim of 10-m crater at station 3

Illustrations: Pan 16; figures 109, 110, 111, 114 (LRL).

Comment.: Light-gray breccia, probably from the South Massif.

Petrographic description: Polymict breccia with clasts of metaclastic and metagabbroid rocks and mineral clasts of plagioclase and olivine in an aphanitic matrix.

Sample 73260-64

Type: Sedimentary, unconsolidated.

Weight: 326.23 g.

Depth: About 5-10 cm below surface in trench.

Location: From trench on rim of 10-m crater at station 3.

Illustrations: Pan 16; figures 109, 110.

Comments: The medium-gray part of the "marbled" zone described by the crew. May also include material from the small patch of light sediment visible in the presampling trench photograph (fig. 109).

Petrographic description: 73260-64, dominantly finegrained breccia and (or) metaclastic rock, some glass, and agglutinate.

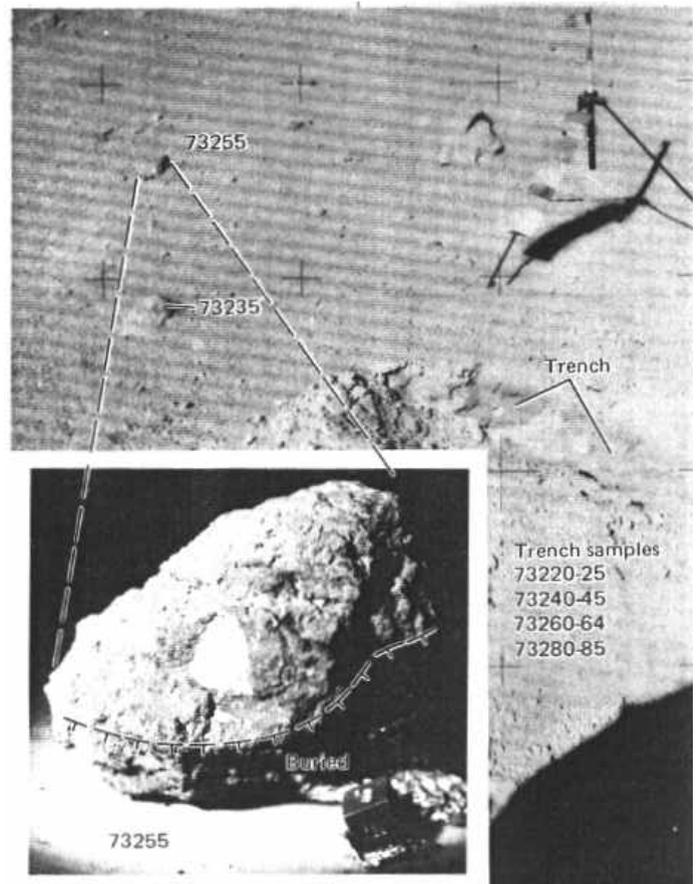


FIGURE 111.-Trench at station 3 from which samples 73220-25, 73240-45, 73260-64, and 73280-85 had been collected and samples 73235 and 73255 before collection. Inset shows 73255 with reconstructed lunar surface orientation and lighting. (NASA photographs AS 17-138-21148; S-73-19592.)



Components of 90-150-µm fraction of 73281,1 (Heiken and McKay, 1974)-Continued

Components	Volume Percent
Glass - Continued	
Brown.....	2.0
Gray, "ropy".....	.3
Other.....	--
Total number of grains.....	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

Major-element composition:

Chemical analyses of 73281

	1	2	3
SiO <sub>2</sub> .....	45.31	46.0	45.7
Al <sub>2</sub> O <sub>3</sub> .....	20.23	20.8	20.5
FeO.....	8.82	8.54	8.68
MgO.....	9.95	9.98	9.96
CaO.....	12.91	11.8	12.4
Na <sub>2</sub> O.....	.41	.445	.43
K <sub>2</sub> O.....	.16	.137	.15
TiO <sub>2</sub> .....	1.76	1.75	1.76
P <sub>2</sub> O <sub>5</sub> .....	.14	--	.14
MnO.....	.11	.110	.11
Cr <sub>2</sub> O <sub>3</sub> .....	.27	.206	.24
Total	100.07	99.768	100.07

1. 73281,12 (Rose and others, 1974).
2. 73281,18 (Wanke and others, 1974).
3. Average of 1 and 2.

Exposure age: <sup>22</sup>Na-<sup>26</sup>Al: 73281, maximum 1.1±0.3 m.y. (Yokoyama and others, 1976).

STATION LRV-5

LOCATION

Station LRV-5 is located on the light mantle 700 m northeast of station 3 (fig. 7A).

OBJECTIVES

Station LRV-5 was an unplanned LRV stop to sample a crater with abundant fragmental ejecta.

GENERAL OBSERVATIONS

The station area is flat to gently rolling with scattered craters up to 15 m in diameter (fig. 116). Most of the craters are subdued or have only slightly raised rims. The one exception is the 15-m crater whose ejecta was sampled. That crater has a raised blocky rim, a high concentration of blocks and fragments on the inner crater wall, and a very blocky ejecta blanket.

Rock fragments or clods range in size from 1 to 50 cm and cover 15 to 20 percent of the ejecta blanket surface. The fragments are dominantly angular and partially buried. No fillets are visible in the photographs.

The LRV sample was collected from the ejecta blanket less than one crater diameter from the rim of the

blocky crater.

SUMMARY OF SAMPLING

Sample 74110-19

Type: Sedimentary, unconsolidated (74110-14) and sedimentary, weakly lithified polymict breccia (74115-19).

Size: Not available.

Weight: 74110-14, 245.41 g; 74115-19, 37.11 g total.

Location: From the ejecta blanket of a 15-m crater in the light mantle at station LRV-5.

Illustration: Figure 116.

Comments: Samples represent light mantle material. The polymict breccia (74115-19) represents the abundant blocks of the crater ejecta, which were probably indurated by the impact that formed the 15-m crater.

Petrographic descriptions:

74110-14, dominantly breccia of several types, finegrained feldspathic cataclastite, agglutinate, and glass.

74115, 16, polymict breccia with clasts of metaclastic rock, fine-grained breccia, orange glass, and mineral debris in a fine-grained friable matrix.

STATION LRV-6

LOCATION

Station LRV-6 is located on the light mantle about 1.1 km northeast of station 3 (fig. 7A).

OBJECTIVES

Station LRV-6 was a planned LRV stop to sample the light mantle.

GENERAL OBSERVATIONS

The station area is flat to gently rolling with scattered craters up to 30 m in diameter. Craters from 5 cm to 2 m are most common; they are mainly shallow and subdued (fig. 117). The surface is saturated with craters less than 5 cm across.

There are scattered rock fragments 1-5 cm in size and a few larger fragments and boulders up to 1 or 2 m in size. Fragments are either perched on the surface or are only slightly buried. Fillets are poorly developed.

SUMMARY OF SAMPLING

Sample 74120-24

Type: Sedimentary, unconsolidated.

Weight: 385.87 g.

Depth: From the upper few centimeters.

*Location:* Light mantle at station LRV-6.

*Illustration:* Figure 117.

*Comments:* Highlands material is dominant (fig. 118), although there is a slightly greater admixture of valley-floor material at station LRV-6 than in sediment samples from closer to the South Massif.

*Petrographic description:* 74120-24, dominantly breccia of several types, metaclastic(?) rock, agglutinate, possibly some basalt.

Components of 90-150-um fraction of 74121.12 (Heiken and McKay, 1974)

Components	Volume Percent
Agglutinate.....	51.7
Basalt, equigranular.....	2.0
Basalt, variolitic.....	2.0
Breccia:	
Low grade <sup>1</sup> - brown.....	7.0
Low grade <sup>1</sup> - colorless.....	5.7
Medium to high grade <sup>2</sup> .....	12.0
Anorthosite.....	.7
Cataclastic anorthosite <sup>3</sup> .....	.7
Norite.....	.7
Gabbro.....	--
Plagioclase.....	7.3
Clinopyroxene.....	3.7
Orthopyroxene.....	1.0
Olivine.....	.3
Ilmenite.....	.7
Glass:	
Orange.....	.3
"Black".....	2.3
Colorless.....	1.7
Brown.....	1.8
Gray, "ropy".....	--
Other.....	.3
Total number of grains.....	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

*Major-element composition:*

Chemical analyses of 74121

	1	2	3	4	5
SiO <sub>2</sub> .....	43.51	44.51	44.9	44.9	44.5
Al <sub>2</sub> O <sub>3</sub> .....	19.41	19.36	18.75	18.97	19.12
FeO.....	10.00	10.24	10.43	10.34	10.25
MgO.....	9.84	9.93	10.20	9.86	9.96
CaO.....	12.11	12.44	11.73	12.2	12.1
Na <sub>2</sub> O.....	.31	.44	.44	.427	.39
K <sub>2</sub> O.....	.19	.134	.136	.135	.15
TiO <sub>2</sub> .....	2.58	2.56	2.47	2.57	2.54
P <sub>2</sub> O <sub>5</sub> .....	.11	.136	.120	.117	.12
MnO.....	.18	.132	.128	.134	.14
Cr <sub>2</sub> O <sub>3</sub> .....	.29	.269	.23	.248	.26
Total	98.53	100.111	99.53	99.901	99.53

1. 74121 (Mason and others, 1974).
2. 74121.2 (Duncan and others, 1974).
3. 74121.16 (Nava, 1974).
4. 74121.18 (Wanke and others, 1974).
5. Average of 1 through 4.

**STATION 4**

LOCATION

Station 4 is located on the southern rim crest of the 110-m crater, Shorty, near the northern terminus of the light mantle (fig. 7A; pl. 2).

OBJECTIVES

Analysis of orbital photographs before the mission suggested that Shorty is a young, rayed, dark-haloed crater formed by an impact that excavated thick dark mantle material from below the light mantle. An alternate hypothesis was that Shorty is a volcanic vent that produced a small amount of dark mantle material after the emplacement of the light mantle. Observation and sampling were planned to examine Shorty crater, to determine its origin, to sample its ejecta, and to examine the distal end of the light mantle and sample its variety of rock types. Because of shortage of time and because of the unique character of the materials found at Shorty, observation and sampling were confined to the crater rim.

GENERAL OBSERVATIONS

Shorty crater has the distinctly raised rim that characterizes the younger impact craters at the Taurus-Littrow site. Its floor is hummocky, with a low central mound and with marginal hummocks that resemble slumps forming discontinuous benches along the lower parts of the crater wall. The central mound is blocky and jagged as are the marginal hummocks or benches.

The walls, rim, and ejecta blanket consist largely of dark material that is much finer grained than the crater floor materials, although blocks occur locally on the crater wall and rim. The dark ejecta blanket is similar in albedo to the nearby dark parts of the valley floor. Fragments up to about 15 cm in diameter cover less than 3 percent of the surface on the crater rim. Scattered larger blocks reach more than 5 m in size. Rock burial ranges from none to almost complete. The rocks range in shape from angular to subrounded. Some of them are filleted, especially on the upslope sides of a few of the larger boulders on the crater walls.

Small craters up to several meters in diameter with rims ranging from sharp to subdued are scattered around the rim and flanks of Shorty crater. Their ejecta are no blockier, except for clods, than the adjacent surfaces.

Samples were collected from a low place on the southern rim crest of Shorty just east of a 5-m boulder of fractured basalt (figs. 119 and 120; pans 17 and 18, pl. 6). Debris that may have been shed from the boulder lies on the nearby surface, and blocks are abundant on this part of the inner crater wall. All of the rocks examined are basalt. They are commonly intensely fractured and some show irregular knobby surfaces that resemble the surfaces of terrestrial flow breccias.

A trench dug in the rim crest exposed orange volcanic ash buried beneath a one-half-cm-thick layer

of gray sediment typical of the general surface material at the station. The orange ash forms a 1-meter-wide unit that trends parallel to the crater rim crest for about 2 m. Color zoning within the ash, as seen in the trench, occurs as 10-cm-wide yellowish bands along the margins of the orange deposit. The yellow bands are in steep sharp contact with gray sediment exposed at each end of the trench, and they grade inward to the more reddish ash that makes up the major part of the zone. A drive tube in the axial part of the colored zone bottomed in black ash. Similar orange material has been excavated by a small fresh crater high on the northwest interior wall of Shorty and perhaps also on the rim' crest a short distance southeast of the LRV.

Samples included three sediment samples from the

trench, a double drive tube 69.2 cm deep, two rock samples broken from boulders, and one ejecta fragment from the surface of the crater rim.

#### GEOLOGIC DISCUSSION

Cratering experiments have shown that craters with flat floors or central mounds may form in targets where unconsolidated material overlies coherent material; the difference in elevation between the precrater surface and the crater floor in such craters is approximately equivalent to the thickness of the unconsolidated layer (Oberbeck and Quaide, 1967; Quaide and Oberbeck, 1968). Topographic profiles made by analytical stereoplotter show that the rocky floor of Shorty crater is approximately 14 m lower than the precrater

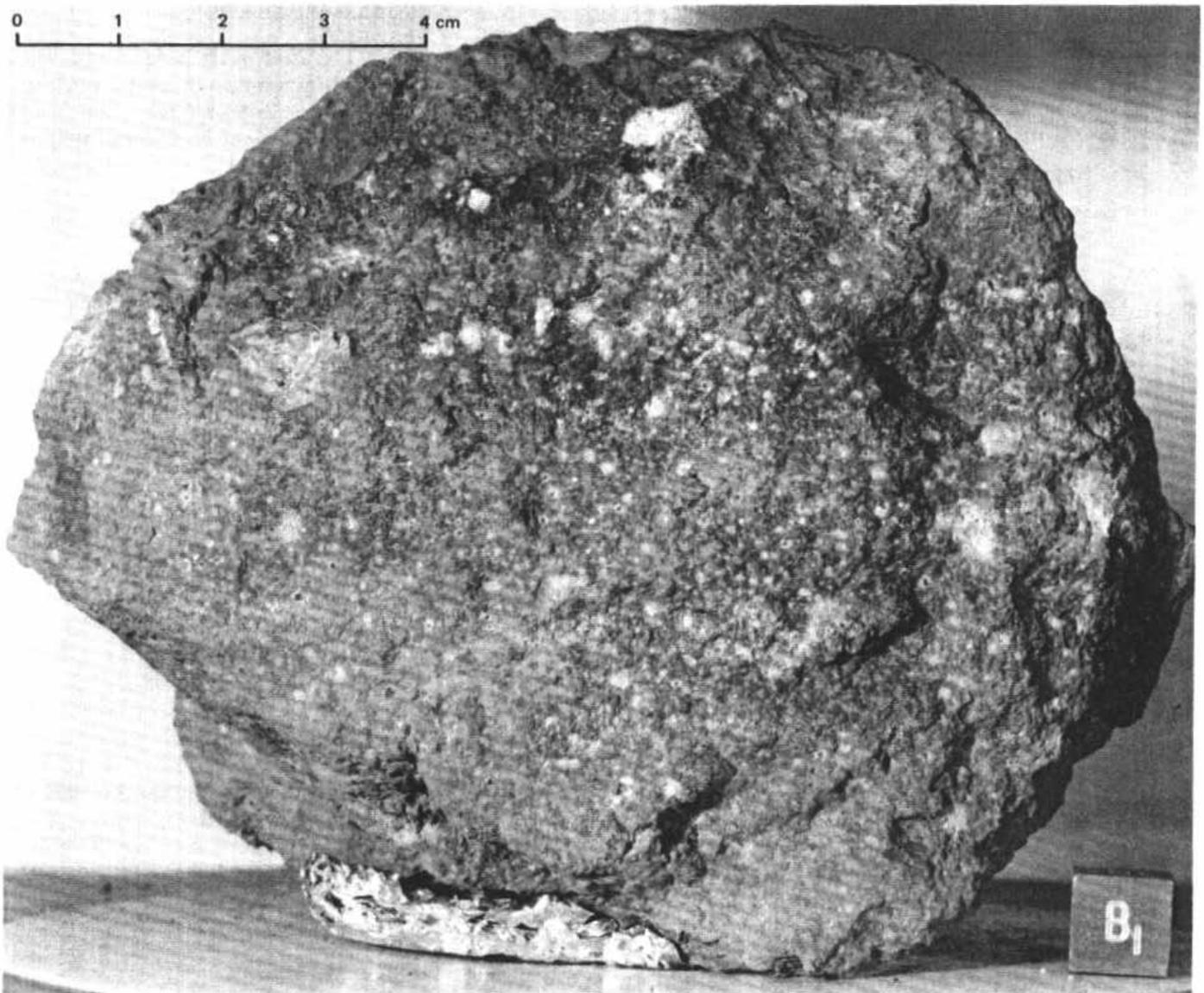


FIGURE 112.-Sample 73235. Polymict breccia with cataclastic matrix. (NASA photograph S-73-16961.)

face. Applying the experimental results and noting blockiness of the crater floor and the occurrence of a few basalt blocks on the rim, we suggest that the subfloor basalt in the Shorty target area was overlain by about 14 m of unconsolidated or poorly consolidated material.

The overburden consisted, in ascending order, of volcanic ash, older regolith of the valley floor, and light

mantle. We interpret the volcanic ash of the trench and double drive tube as a clod of ejecta excavated from a remnant of an ash blanket deposited on the surface of the subfloor basalt about 3.5 b.y. ago. The light-gray sediment of the trench is typical (fig. 121) of the mixture of highlands and valley floor debris that makes up

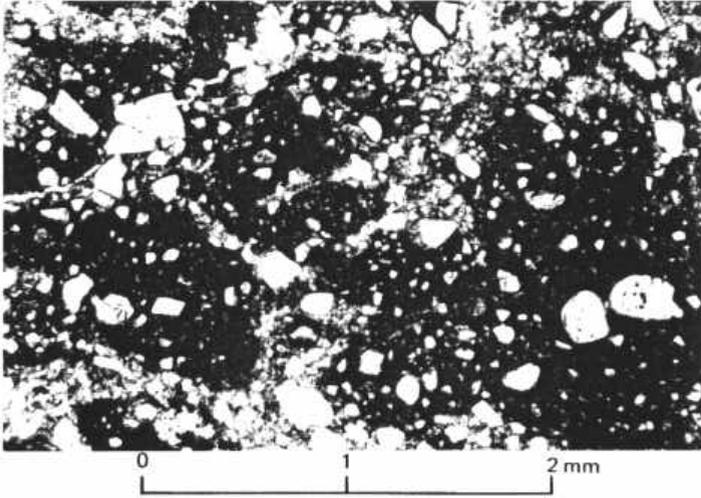


FIGURE 113.-Sample 73235. Photomicrograph showing clasts of phanitic breccia in matrix of broken, dominantly feldspathic mineral debris.

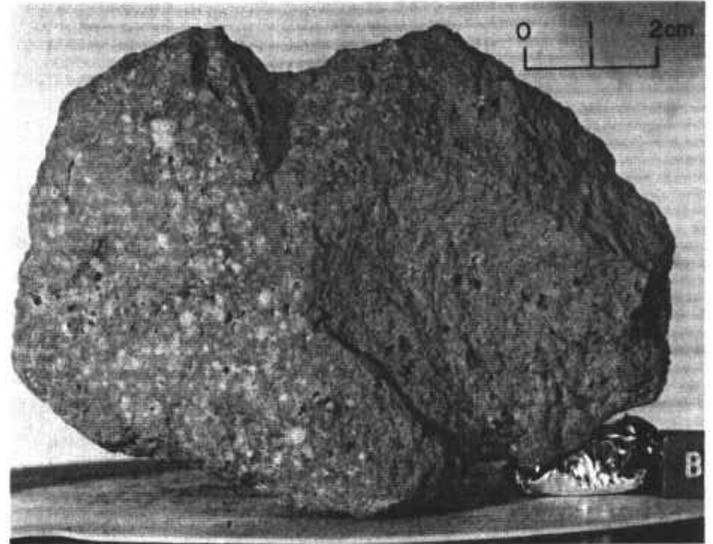


FIGURE 115.-Sample 73275. Metaclastic rock with granoblastic matrix. (NASA photograph S-73-16929.)

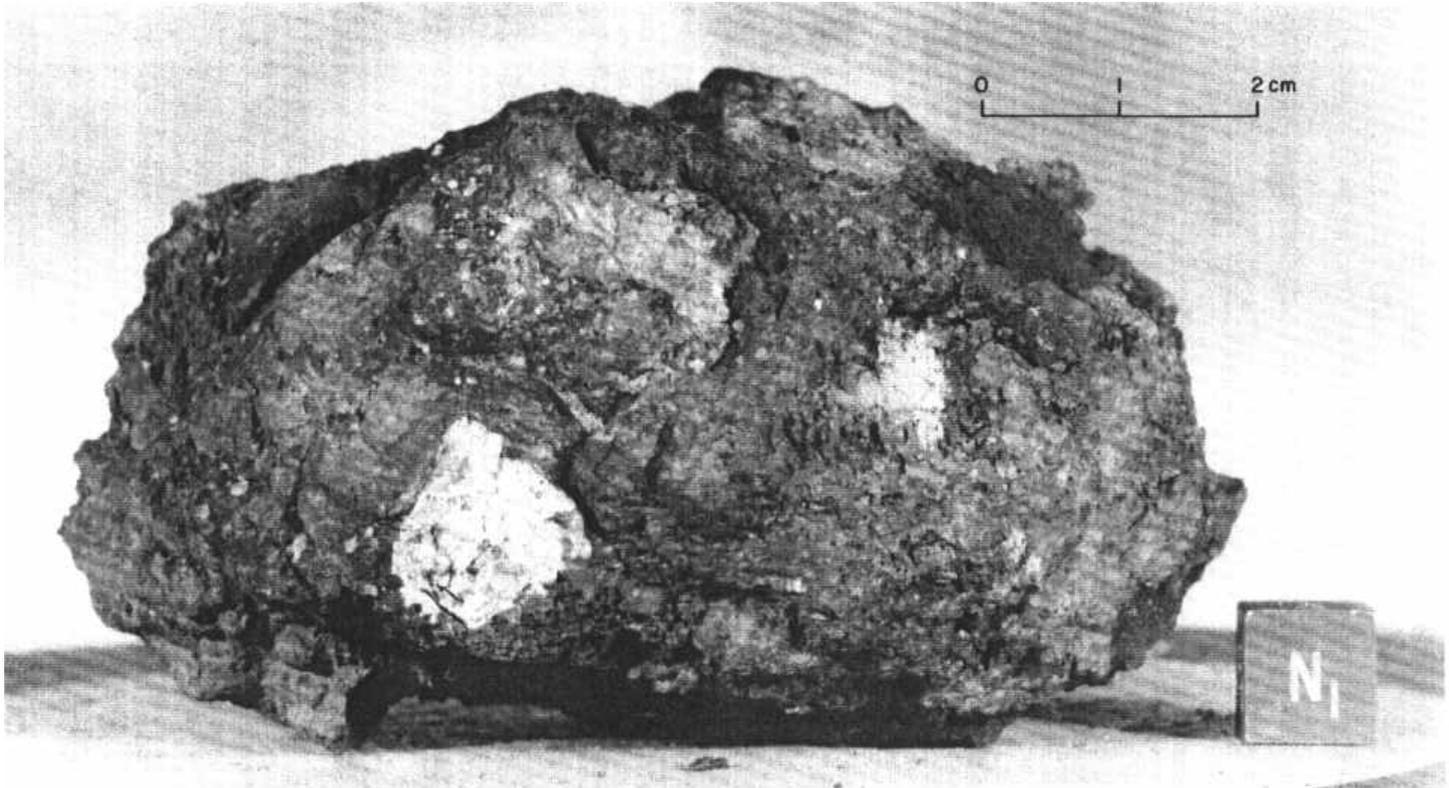


FIGURE 114.-Sample 73255. Polymict breccia with aphanitic matrix. (NASA photograph S-73-16951.)

the older regolith of the valley floor. Light mantle, which was at the surface where Shorty formed, is not recognized in the samples. It presumably is buried within the ejecta by material excavated from greater depth.

On the basis of major-element composition, station 4 basalt is generally similar to that from the LM and station 1. However, on the basis of trace-element distributions, particularly the uniquely low Ba/Rb ratio, Rhodes and others (1976) concluded that the station 4 basalt samples (74245, 74255, and 74275) were from a distinct flow not sampled at other stations.

Shorty crater was probably excavated between about 10 and 30 m.y. ago. Noble-gas exposure ages determined for the orange volcanic ash and for basalt sample 74275 are about 30 m.y. An exposure age of approximately 17 m.y. was determined for basalt sample 74255. Track ages of about 10 m.y. have been determined for the orange volcanic ash by several investigators, some of whom have suggested that the slightly older noble-gas ages record a brief irradiation of the ash between its initial deposition and subsequent burial about 3.5 b.y. ago.

*Depth:* Approximately 71 cm.

*Weight:* 1,981.6 g net.

*Location:* East of 5-m boulder on south rim of Shorty crater.

*Illustrations:* Pans 17, 18; figures 120, 122, 122.1.

*Comments:* The cored material is unusually compact. The lower tube (74001) has recently been opened and consists of poorly bedded layers of black ash (G. H. Heiken, written commun., 1977). The contact between the black ash and the overlying orange ash, which is exposed in the trench, occurs within the upper drive tube (74002) at a depth estimated from the debris smeared on the exterior of the tube to be approximately 25 cm (fig. 122). The ash on the crater rim probably represents a clod of ejecta excavated in the Shorty impact from remnants of a once-continuous ash deposit overlying the subfloor basalt.

*Petrographic description:* (bottom of lower drive tube) volcanic ash, fine-grained, dark to opaque and black spheres and conchoidal fragments.

SUMMARY OF SAMPLING

Sample 74002/74001 (upper/lower)

*Type:* Double drive tube.

*Length:* 69 .2 cm (74001, 35.7 cm; 74002, 33.5 cm).

Components of 90 - 150 -  $\mu$ m fraction of 74001,2 (bottom of double drive tube) (Heiken and Mckay, 1974)

Components	Volume Percent
Agglutinate.....	--
Basalt, equigranular.....	--
Basalt, variolitic.....	--
Breccia:	
Low grade <sup>1</sup> - brown.....	--
Low grade <sup>1</sup> - colorless.....	--
Medium to high grade <sup>2</sup> .....	--

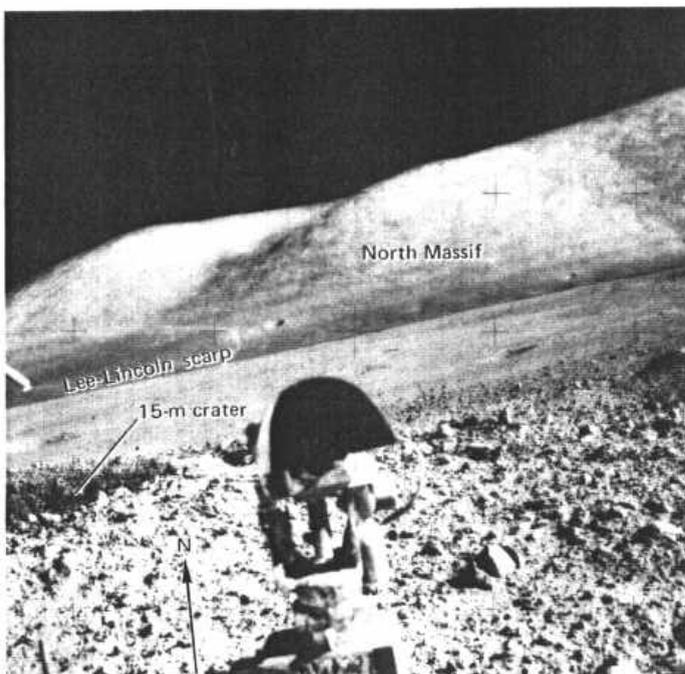


FIGURE 116.-Station LRV-5 area before sampling. Sample 74110-19 was probably collected from blocky ejecta in near field. (NASA photograph AS 17-133-20208.)

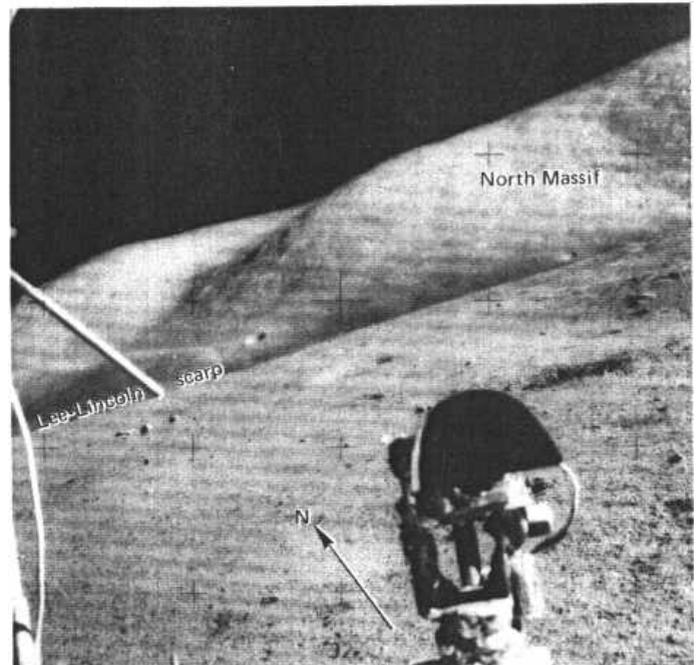


FIGURE 117.-Station LRV-6 area. Sample 74120-24 may have been collected in near-field area of this view. (NASA photograph AS 17-133-20212.)

Components of 90 - 150 - um fraction of 74001,2 (bottom of double drive tube) (Heiken and McKay,1974) -Continued

Components	Volume Percent
Anorthosite.....	--
Cataclastic anorthosite <sup>3</sup> .....	--
Norite.....	--
Gabbro.....	--
Plagioclase.....	1.6
Clinopyroxene.....	.3
Orthopyroxene.....	--
Olivine.....	--
Ilmenite.....	--
Glass:	
Orange.....	8.0
"Black".....	73.3
Colorless.....	--
Brown.....	16.6
Gray, "ropy".....	--
Other.....	--
<b>Total number of grains.....</b>	<b>300</b>

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

**Major- element composition:**

Chemical analyses of 74001(Heiken and others, 1974)

	1	2	3	4	5	6
SiO <sub>2</sub> .....	39.38	38.38	39.14	38.61	38.16	38.73
Al <sub>2</sub> O <sub>3</sub> .....	6.06	5.91	5.82	6.33	5.78	5.98
FeO.....	22.44	22.25	23.29	22.84	22.16	22.60
MgO.....	10.29	14.87	14.54	16.16	15.12	14.20
CaO.....	9.55	7.40	7.32	7.08	7.29	7.73
Na <sub>2</sub> O.....	.32	.40	.37	.25	.40	.35
K <sub>2</sub> O.....	.06	.07	.07	.06	.08	.07
TiO <sub>2</sub> .....	10.34	9.19	9.03	9.81	8.95	9.46
P <sub>2</sub> O <sub>5</sub> .....	--	--	--	--	--	--
MnO.....	--	--	--	--	--	--
Cr <sub>2</sub> O <sub>3</sub> .....	.56	.59	.54	.71	.56	.59
<b>Total</b>	<b>99.00</b>	<b>99.06</b>	<b>100.12</b>	<b>101.85</b>	<b>98.50</b>	<b>99.71</b>

1. 74001,2-4 black droplets, 95 percent crystallized.
2. 74001,2-5 clear orange glass.
3. 74001,2-6 surface droplets.
4. 74001,2-7 surface droplets.
5. 74001,2-8 clear orange glass.
6. Average of 1 through 5.

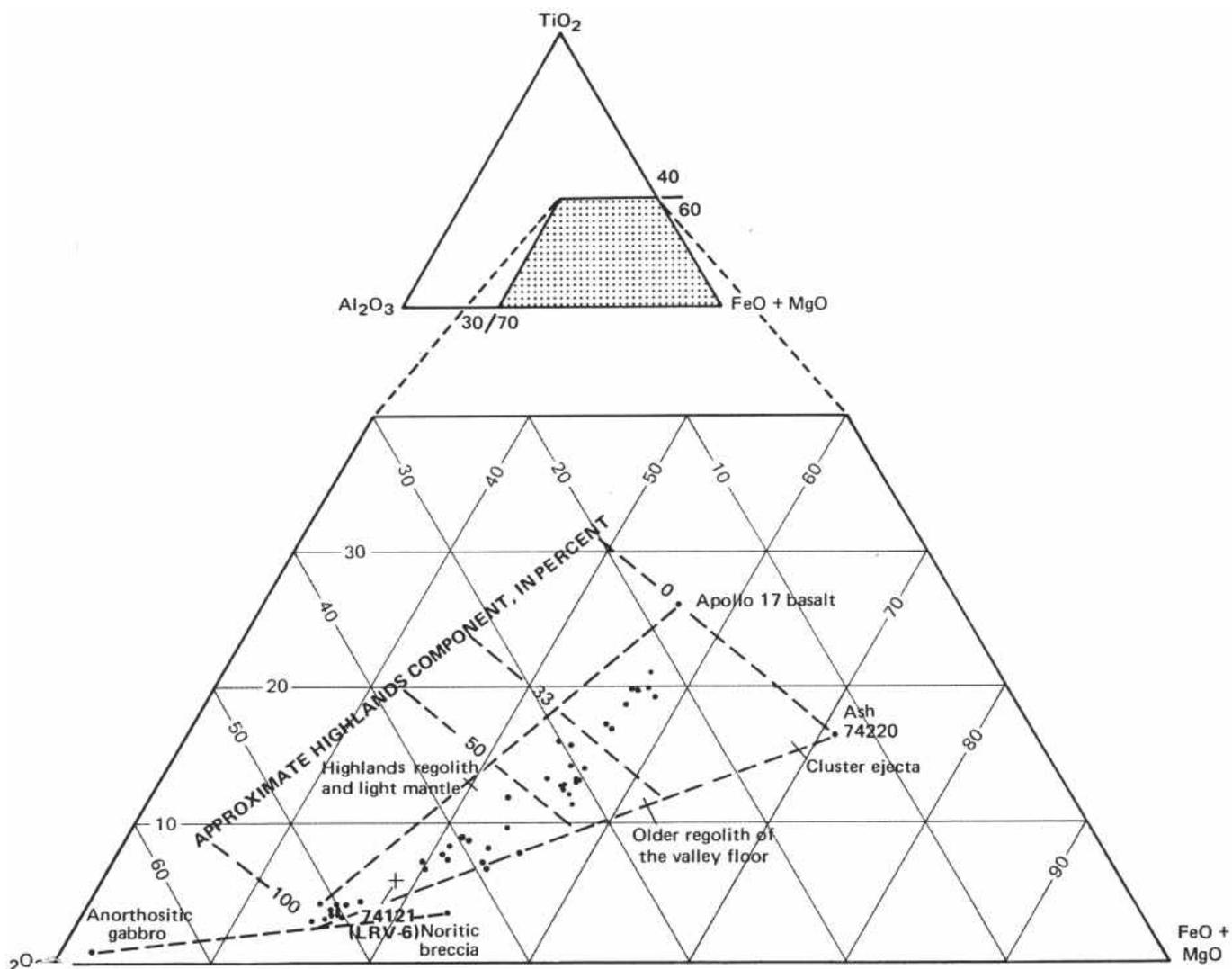


FIGURE 118.-Relative amounts of TiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, and FeO+MgO in sediment sample 74121 (cross), collected at station LRV-6, in comparison with sediment samples from rest of traverse region (dots).

*Exposure age:* Ne and Ar: 45 m.y. on sample from bottom of double drive tube at approximately 70 cm depth (Eberhardt and others, 1974).

Sample 74220

*Type:* Volcanic ash.

*Weight:* 1,180 g.

*Depth:* 5-8 cm.

*Location:* From center of meter-long trench east of the 5-m boulder on the south rim of Shorty crater.

*Illustrations:* Pans 17, 18; figures 120, 122, 123 (photomicrograph).

*Comments:* The reddish zone in the trench, about 80 cm wide, grades laterally into yellowish zones, each about 10 cm wide. These are in turn in sharp steep contact with light-gray sediment exposed at each end of the trench. Figure 122 shows the inferred relations between the materials of the trench and double drive tube (74002/74001). The ash is more coherent than normal sediment from the regolith surface; it has fractured, in the trench wall, to form chunks 1 to 6 cm long. Some of the chunks are color zoned, becoming darker inward, within the outer 2 cm (Butler, 1973).

Orange and black ash of the trench and double drive tube are interpreted as samples of weakly indurated ash from an ejected clod that was deposited on the rim of Shorty during formation of the crater. Presumably the clod was excavated from a layer of

ash that once formed a continuous deposit overlying the subfloor basalt.

*Petrographic description:* Poorly consolidated ash composed of orange glass spherules and partly crystallized spherules and glass shards.

*Components of 90-150 ~ um fraction of 74220 (Heiken and McKay, 1974)*

Components	Volume Percent	
	1	2
Agglutinate.....	1.3	2.7
Basalt, equigranular.....	1.6	2.0
Basalt, variolitic.....	1.6	2.0
Breccia:		
Low grade <sup>1</sup> - brown.....	.3	--
Low grade <sup>1</sup> - colorless.....	--	1.3
Medium to high grade <sup>2</sup> .....	--	--
Anorthosite.....	--	--
Cataclastic anorthosite <sup>3</sup> .....	--	--
Norite.....	--	--
Gabbro.....	--	--
Plagioclase.....	--	1.0
Clinopyroxene.....	.3	.3
Orthopyroxene.....	--	--
Olivine.....	--	--
Ilmenite.....	--	.3
Glass:		
Orange.....	66.3	83.6
"Black".....	29.3	6.7
Colorless.....	.3	--
Brown.....	--	1.3
Gray, "ropy".....	--	.7
Other.....	--	--
Total number of grains.....	300	300

<sup>1</sup>Metamorphic groups 1-3 of Warner (1972).

<sup>2</sup>Metamorphic groups 4-8 of Warner (1972).

<sup>3</sup>Includes crushed or shocked feldspar grains.

1. 74220,6

2. 74220,82

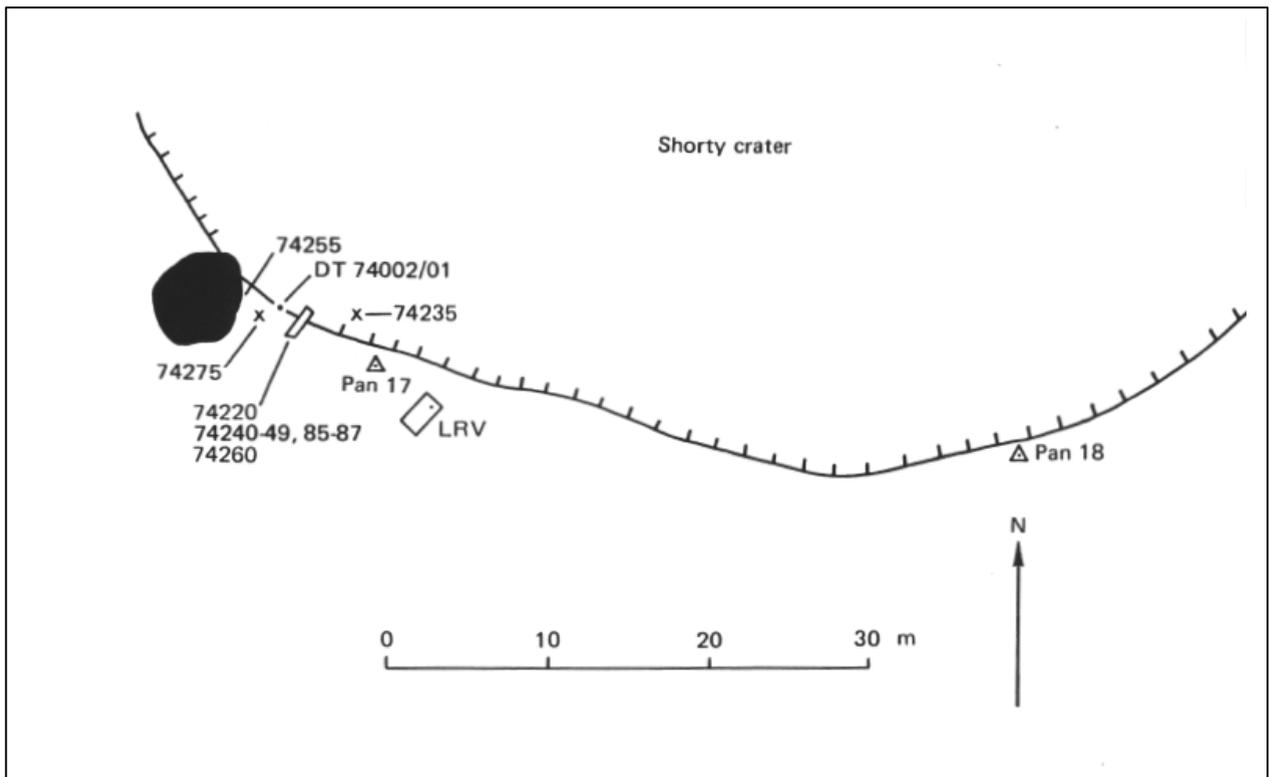


FIGURE 119.-Planimetric map of station 4.

Modes are from loose material around the clods and contamination from thin surface sediment layer. sections of a clod show 100 percent orange glass or its equivalent, the partly crystallized black spheres (G. H. Heiken, written commun., 1977).

Major-element composition:

Chemical analyses of 74220

	1	2	3	4	5	6
SiO <sub>2</sub> .....	38.55	38.0	39.4	39.13	39.5	37.6 -43.5
Al <sub>2</sub> O <sub>3</sub> .....	5.85	5.51	6.02	6.18	6.0	1.49 -9.05
FeO.....	21.96	22.4	22.7	22.38	23.0	22.0 -24.8
MgO.....	14.99	14.5	15.5	16.79	15.5	5.08 -35.3
CaO.....	7.16	6.99	6.42	6.94	6.5	1.33 -10.6
Na <sub>2</sub> O.....	.33	.39	.69	.34	.65	.19 -1.03
K <sub>2</sub> O.....	--	.06	.0	.03	.0	.0 -0.7
TiO <sub>2</sub> .....	8.87	8.87	9.30	8.33	9.0	2.32 -13.7
P <sub>2</sub> O <sub>5</sub> .....	--	--	--	--	--	-- --
MnO.....	--	--	.30	--	.28	.05 -4.8
Cr <sub>2</sub> O <sub>3</sub> .....	.55	.70	--	.53	--	-- --
Total	98.26	97.42	100.33	100.65	100.43	

	7	8	9	10	11	12
SiO <sub>2</sub> .....	38.57	39.03	39.4	38.9	39.0	38.6
Al <sub>2</sub> O <sub>3</sub> .....	6.32	6.47	6.52	6.38	6.42	5.79
FeO.....	22.04	22.13	21.9	22.34	22.1	22.4
MgO.....	14.44	14.44	14.01	14.76	14.41	15.0
CaO.....	7.68	7.62	7.4	7.01	7.4	6.86
Na <sub>2</sub> O.....	.36	.34	.396	.43	.38	.47
K <sub>2</sub> O.....	.09	.077	.076	.076	.80	.03
TiO <sub>2</sub> .....	8.81	8.72	8.09	8.96	8.64	9.01
P <sub>2</sub> O <sub>5</sub> .....	.04	.043	.048	.097	.06	--
MnO.....	.30	.273	.252	.255	.27	.3
Cr <sub>2</sub> O <sub>3</sub> .....	.75	.684	.589	.68	.68	.62
Total	99.40	99.827	99.681	99.89	100.16	99.08

- 74220, microbe analyses of orange glass, 47 analyses of relatively homogeneous orange glass; largest standard deviation, for MgO, is 0.44 (Reid and others, 1973).
- 74220.87, microbe analyses of orange glass, 16 analyses (Carter and others, 1973).
- 74220.89, microbe analyses of orange glass, 19 analyses (Glass, 1973).
- 74220, microbe analyses of black opaque crystalline fragments, 33 analyses of relatively heterogeneous fragments (larger standard deviations are: Al<sub>2</sub>O<sub>3</sub>, 1.05; MgO, 4.79; CaO, 1.45; TiO<sub>2</sub>, 1.64). Average (column 4) is similar to orange glass values (Reid and others, 1973).
- 74220.89, mode of 40 microbe analyses of heterogeneous black opaque fragments; modal value is similar to composition of orange glass; heterogeneity interpreted as due to addition or subtraction of olivine (Glass, 1973).
- 74220.89, ranges for values given in column 5.
- 74220.3 bulk sample (Apollo 17 PET, 1973).
- 74220.31 bulk sample (Duncan and others, 1974).
- 74220.36 bulk sample (Wanke and others, 1973).
- 74220.40 bulk sample (Nava, 1974).
- Average for bulk sample, columns 7 through 10.
- Average for orange glass, columns 1 through 3.

Age:

<sup>40-39</sup>Ar:

74220,39, 3.71±0.06 b.y. (Husain and Schaeffer, 1973).

74220, 3.67 b.y., mean of four determinations ranging from 3.60 to 3.71 b.y. (Eberhardt and others, 1973).

K-Ar:

74220,47, 3.5±0.3 b.y. (Hintenberger and Weber, 1973).

Fission track:

74220, 3.7 b.y. (Hutcheon and others, 1974b).

U-Pb:

74220, 3.63 b.y. (Tatsumoto and others, 1973).

Pb-Pb:

74220, 3.48±0.03 b.y.; determined for carefully separated and cleaned glass spheres; determinations of greater age (above) attributed to Ar entrapment and Pb contamination by components other than orange glass in 74220 (Tera and Wasserburg, 1976).

Exposure age:

Ar:

74220,13, 30±6 m.y. (Huneker and others, 1973).

74220,15, 30 m.y. (Eberhardt and others, 1974).

74220,39, 32±4 m.y. (Husain and Schaeffer, 1973).

74220,30 m.y. (Kirsten and others, 1973).

Ne:

74220,29 m.y. (Kirsten and others, 1973). Tracks:

74220,20-35 m.y. maximum residence time at 5.0-7.5-cm depth (Fleischer and others, 1974); 4-7 m.y. since last disturbance of material at 5.0-7.5-cm depth suggested by minimum track densities (Fleischer and others, 1974).

74220,68, ~9-11 m.y. (Storzer and others, 1973).

74220,9.1-13.6 m.y.; inferred as maximum for residence in sampling position; 30-m.y. noble-gas ages (above) interpreted as indicative of two-stage exposure history (Hutcheon and others, 1974b).

74220,10 m.y.; interpreted as age of Shorty Crater (Kirsten and others, 1973); 30-m.y. rare-gas ages (above) may imply brief period of irradiation immediately after initial deposition on the lunar surface (~3.5 b.y. ago).

Sample 74235

Type: Olivine basalt.

Size: 4.3x3.4x3.3 cm.

Weight: 59.04 g.

Location: East of the 5-m boulder on the south rim of Shorty crater.

Illustrations: Pans 17, 18; figure 124 (photomicrograph).

Comments: Ejecta fragment.

*Petrographic description:* Very fine grained vesicular olivine basalt. Quench olivine in variolitic groundmass of abundant opaque needles and intergrowths of pyroxene and plagioclase.

*Major-element composition:*

*Chemical analyses of 74235*

	1	2	3
SiO <sub>2</sub> .....	39.42	38.62	39.02
Al <sub>2</sub> O <sub>3</sub> .....	9.21	8.61	8.91
FeO.....	18.55	19.31	18.93
MgO.....	8.67	8.35	8.51
CaO.....	10.85	10.70	10.78
Na <sub>2</sub> O.....	.37	.40	.38
K <sub>2</sub> O.....	.08	.07	.08
TiO <sub>2</sub> .....	12.39	12.17	12.28
P <sub>2</sub> O <sub>5</sub> .....	.05	.05	.05
MnO.....	.27	.28	.28
Cr <sub>2</sub> O <sub>3</sub> .....	.47	.51	.49
Total	100.33	99.07	99.71

1. 74235,18 (Rose and others, 1975).
2. 74235,21 (Rhodes and others, 1976).
3. Average of 1 and 2.

*Exposure age:*

Kr: 74235,9, 188±20 m.y. (Eberhardt and others, 1975).  
Ar: 74235,9, 180±20 m.y. (Eberhardt and others, 1975).

Sample 74240-49, 85-87

*Type:* Sedimentary, unconsolidated (74240-44), basalt fragments (74245, 47-49, 85-87), and weakly lithified polymict breccia (74246).

*Weight:* 74240-44, 924.32 g; 74245-49, 85-87, 116.66 g.

*Depth:* 5-8 cm.

*Location:* Southwest end of trench on the south rim of Shorty crater.

*Illustrations:* Pans 17, 18; figures 120, 122.

*Comments:* From the gray sediment adjacent to the 1-m-wide band of orange volcanic ash.

*Petrographic descriptions:*

74240-44, dominantly basalt, same glass, minor friable feldspathic clastic rocks.

*Components of 90-150- um fraction of 74240,6 (Heiken and McKay, 1974 )*

Components	Volume Percent
Agglutinate.....	8.0
Basalt, equigranular.....	30.0
Basalt, variolitic.....	30.0
Breccia:	
Low grade <sup>1</sup> - brown.....	1.6
Low grade <sup>1</sup> - colorless.....	13.3
Medium to high grade <sup>2</sup> .....	2.0
Anorthosite.....	--
Cataclastic anorthosite <sup>3</sup> .....	.6
Norite.....	--
Gabbro.....	--
Plagioclase.....	4.6
Clinopyroxene.....	11.3
Orthopyroxene.....	--

*Components of 90-150-,um fraction of 74240,6 (Heiken and McKay, 1974)-Continued*

Components	Volume Percent
Olivine.....	--
Ilmenite.....	1.3
Glass:	
Orange.....	4.0
"Black".....	--
Colorless.....	4.6
Brown.....	3.6
Gray, "ropy".....	14.3
Other.....	.3
Total number of grains.....	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

74245, aphanitic vesicular olivine basalt.

74246, polymict (?) breccia with clasts of basalt in a fine-grained friable matrix.

74247, aphanitic vesicular olivine (?) basalt.

74248, aphanitic basalt.

*Major- element compositions:*

*Chemical analyses of 74240 and 74241*

	1	2	3	4	5	6
SiO <sub>2</sub> .....	40.78	42.4	42.3	42.00	41.55	42.1
Al <sub>2</sub> O <sub>3</sub> .....	12.54	13.91	13.69	13.19	13.35	13.54
FeO.....	15.84	15.2	14.66	14.84	14.89	14.90
MgO.....	9.15	9.27	9.88	9.17	9.19	9.38
CaO.....	11.36	11.42	10.89	11.56	11.54	11.35
Na <sub>2</sub> O.....	.38	.453	.48	.43	.48	.46
K <sub>2</sub> O.....	.12	.104	.123	.14	.12	.12
TiO <sub>2</sub> .....	8.61	6.49	7.33	7.90	7.45	7.29
P <sub>2</sub> O <sub>5</sub> .....	.09	.099	.124	.10	.10	.11
MnO.....	.24	.192	.202	.20	.22	.20
Cr <sub>2</sub> O <sub>3</sub> .....	.41	.339	.38	.42	.41	.39
Total	99.52	99.877	100.06	99.95	99.30	99.84

1. 74240,3 (Apollo 17 PET, 1973).
2. 74241,19 (Wanke and others, 1973).
3. 74241,20 (Nava, 1974).
4. 74241,29 (Rose and others, 1974).
5. 74241,50 (Rhodes and others, 1974).
6. Average of 2 through 5.

*Chemical analyses of 74245*

SiO <sub>2</sub> .....	38.59
Al <sub>2</sub> O <sub>3</sub> .....	8.72
FeO.....	18.06
MgO.....	9.65
CaO.....	10.59
Na <sub>2</sub> O.....	.36
K <sub>2</sub> O.....	.06
TiO <sub>2</sub> .....	11.92
P <sub>2</sub> O <sub>5</sub> .....	.04
MnO.....	.27
Cr <sub>2</sub> O <sub>3</sub> .....	.54
Total	98.80

74245,4-7 (Rhodes and others, 1976).

*Age*

<sup>40-39</sup>Ar:

74243,4,A (2-4-mm basalt fragment),

3.78±0.04 b.y.(Kirsten and Horn,1974).

74243,4,C (2-4-mm basalt fragment), 3.93

b.y. interpreted as tentative older age limit (Kirsten and Horn, 1974).

Sample 74255

Type: Olivine basalt.

Size: 13x7x6 cm.

Weight: 737.3 g.

Location: Base of 5-m boulder on south rim of Shorty crater

crater

Illustrations: Pans 17, 18; figures 120, 125 (LRL).

Comments: Subfloor basalt.

Petrographic description: Medium-grained vesicular porphyritic olivine basalt. Aggregates of clinopyroxene-ilmenite in a poorly developed subophitic groundmass of plagioclase, clinopyroxene, ilmenite, olivine, and accessory minerals.

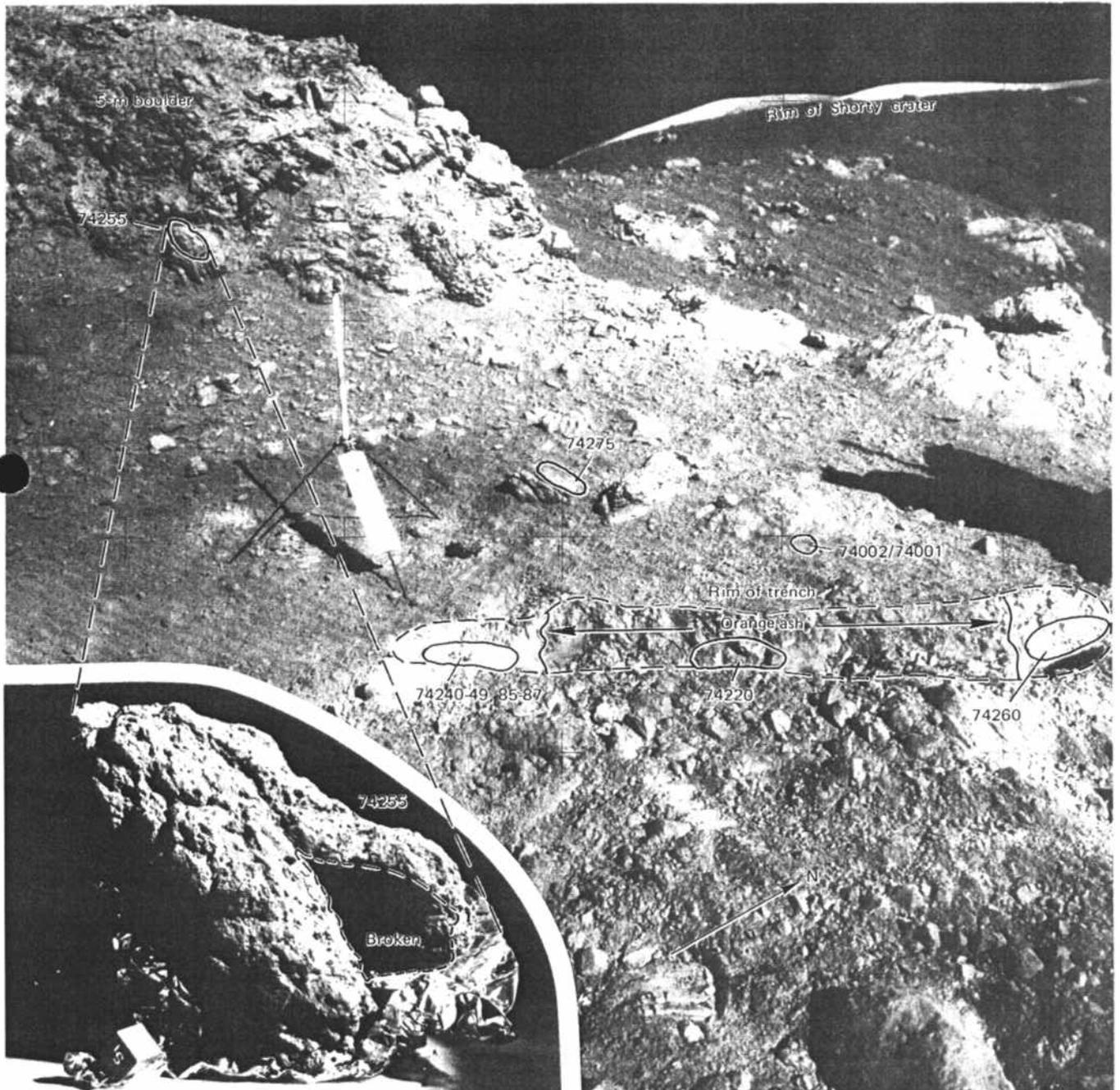


FIGURE 120. -Station 4 area showing locations of drive tube (74002/74001), trench samples (74220, 74240-49, 85-87, 74260), and basalt samples 74255 and 74275 before collection. Inset shows 74255 with reconstructed lunar surface orientation and lighting. (NASA photographs AS17-137-20990; S-73-18404.)

Major-element composition:

Chemical analyses of 74255

	1	2	3
SiO <sub>2</sub> .....	37.96	38.40	38.18
Al <sub>2</sub> O <sub>3</sub> .....	8.55	8.84	8.70
FeO.....	18.11	17.98	18.04
MgO.....	10.50	10.72	10.61
CaO.....	10.35	10.20	10.28
Na <sub>2</sub> O.....	.36	.37	.36
K <sub>2</sub> O.....	.08	.10	.09
TiO <sub>2</sub> .....	12.17	12.76	12.46
P <sub>2</sub> O <sub>5</sub> .....	.05	.06	.06
MnO.....	.27	.28	.28
Cr <sub>2</sub> O <sub>3</sub> .....	.58	.60	.59
Total	98.98	100.31	99.65

1. 74255,25 (Rhodes and others, 1976).
2. 74255,42 (Rose and others, 1975).
3. Average of 1 and 2.

Age:

Rb-Sr isochron:

74255,25, 3.83±0.07 b.y. (Bansal and others, 1975).

74255,25, 3.70±0.12 (20) b.y. (Murthy, 1976).

Exposure age: Kr: 74255,18, 17.3±1.0 m.y. (Eberhardt and others, 1975).

Sample 74260

Type: Sedimentary, unconsolidated.

Weight:: 526.7 g.

Depth: 5-8 cm.

Location: Northeast end of trench on the south rim of

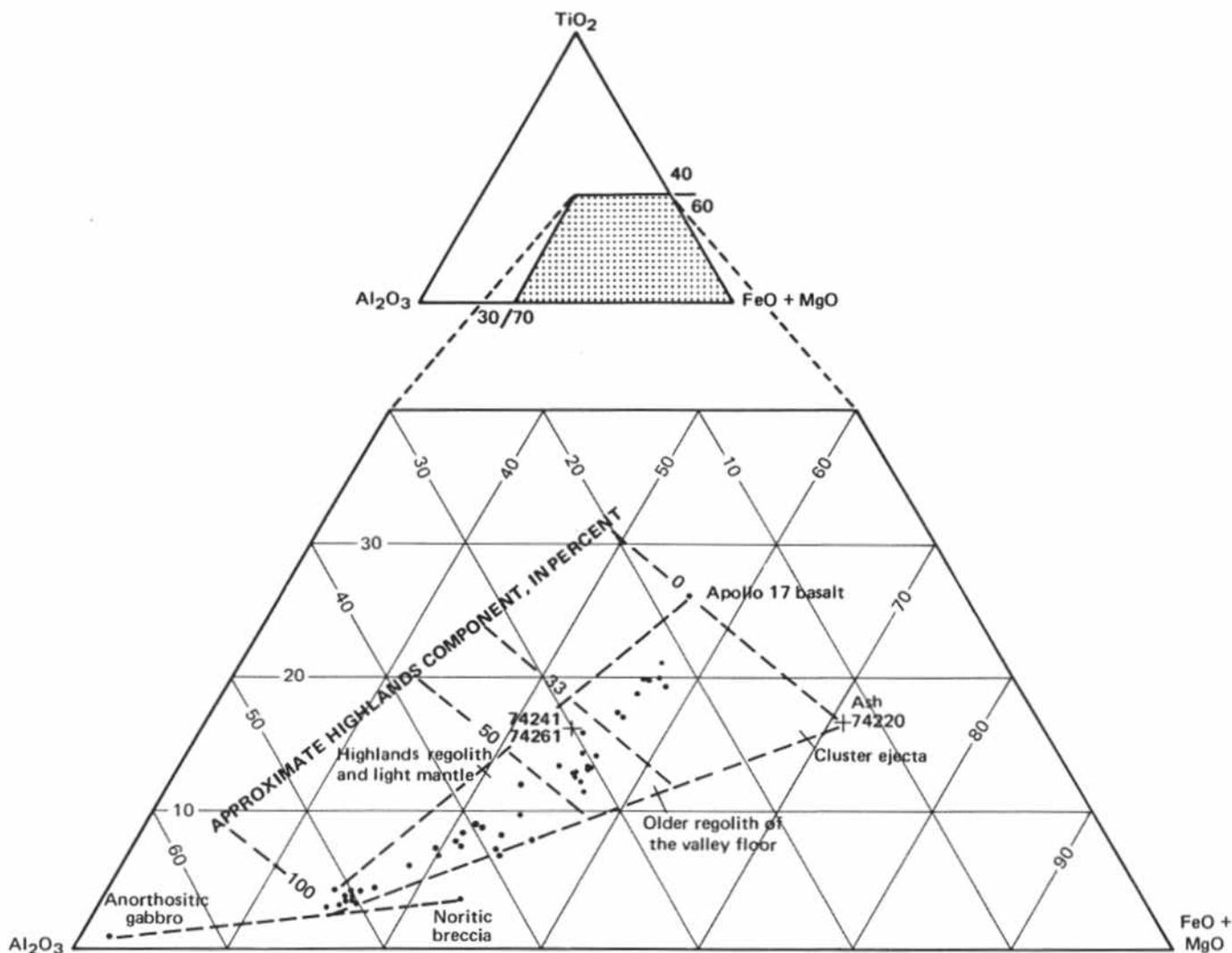


FIGURE 121.-Relative amounts of TiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, and FeO+MgO in volcanic ash 74220 and sediment samples 74241 and 74261 (crosses), collected from trench at station 4, in comparison with sediment samples from rest of traverse region (dots). Apollo 17 basalt, anorthositic gabbro, and noritic breccia values from Rhodes and other (1974).

Shorty crater.

Illustrations: Pans 17, 18: figures 120, 122.

Comments: From the light-gray sediment northeast of the orange volcanic ash in the trench exposure.

Petrographic description: 74260, dominantly basalt, breccia, glass, and agglutinate.

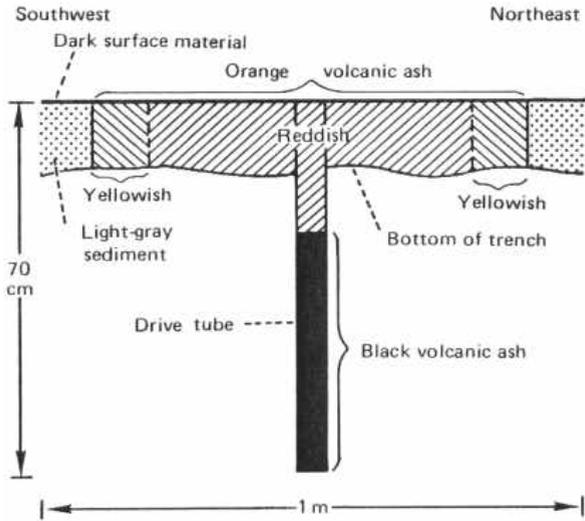


FIGURE 122.-Schematic cross section showing materials in trench and double drive tube on rim crest of Shorty crater (modified from Muelberger and other, 1973).

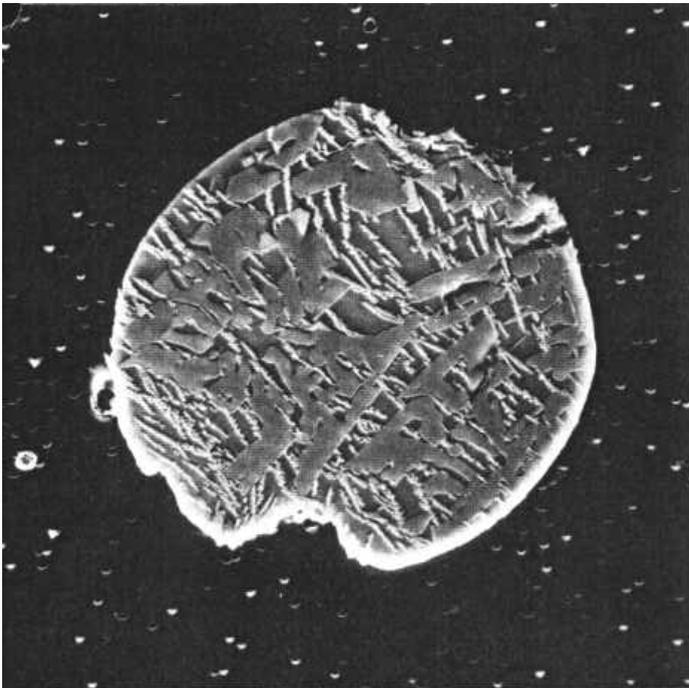


FIGURE 122.1.-Scanning electron micrograph of ion-etched 40-um sphere from sample 74001.2. Exhibiting a quench texture typical of black droplets, it consists of olivine (largest, best developed crystals) and minor spinel (blocky bright crystals). Low-relief area is orange glass, similar in composition to other orange glass. (NASA photograph S77-21580.)

Components of 90-150-um fraction of 74260,5 (Heiken and McKay, 1974)

Components	Volume Percent
Agglutinate.....	7.7
Basalt, equigranular.....	23.7
Basalt, variolitic.....	23.7
Breccia:	
Low grade <sup>1</sup> - brown.....	7.4
Low grade <sup>1</sup> - colorless.....	5.4
Medium to high grade <sup>2</sup> .....	3.3
Anorthosite.....	--
Cataclastic anorthosite <sup>3</sup> .....	--
Norite.....	--
Gabbro.....	--
Plagioclase.....	2.7
Clinopyroxene.....	13.7
Orthopyroxene.....	--
Olivine.....	.3
Ilmenite.....	2.3
Glass:	
Orange.....	7.7
"Black".....	2.0
Colorless.....	3.7
Brown.....	1.7
Gray, "ropy".....	18.1
Other.....	.3
Total number of grains.....	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

Major-element compositions:

Chemical analyses of 74260 and 74261

	1	2
SiO <sub>2</sub> .....	41.22	42.08
Al <sub>2</sub> O <sub>3</sub> .....	13.25	13.70
FeO.....	15.31	14.96
MgO.....	9.47	9.56
CaO.....	11.37	11.25
Na <sub>2</sub> O.....	.38	.42
K <sub>2</sub> O.....	.12	.13
TiO <sub>2</sub> .....	7.68	7.45
P <sub>2</sub> O <sub>5</sub> .....	.09	.09
MnO.....	.23	.19
Cr <sub>2</sub> O <sub>3</sub> .....	.41	.48
Total	99.53	100.31

1. 74260,2 (Apollo 17 PET, 1973).
2. 74261,16 (Rose and others, 1974).

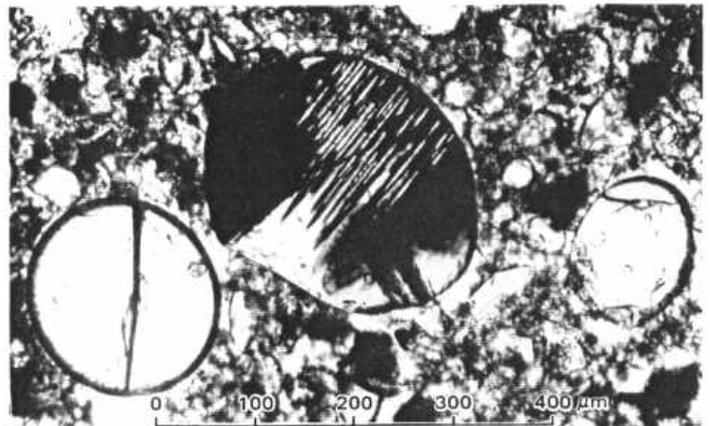


FIGURE 123.-Sample 74220. Photomicrograph showing partly crystallized (to olivine and opaque material) spheres and ellipsoids of orange glass in matrix of orange glass shards.

Sample 74275

Type: Olivine basalt.

Size: 17x12x4 cm.

Weight: 1,493 g.

Location: From 20-cm boulder east of the 5-m boulder on the south rim of Shorty crater.

Illustrations: Pans 17, 18; figures 120, 126, 127 (photomicrograph).

Petrographic description: Medium-grained vesicular porphyritic olivine basalt with olivine phenocrysts and scarce small "dunite" xenoliths in an inter

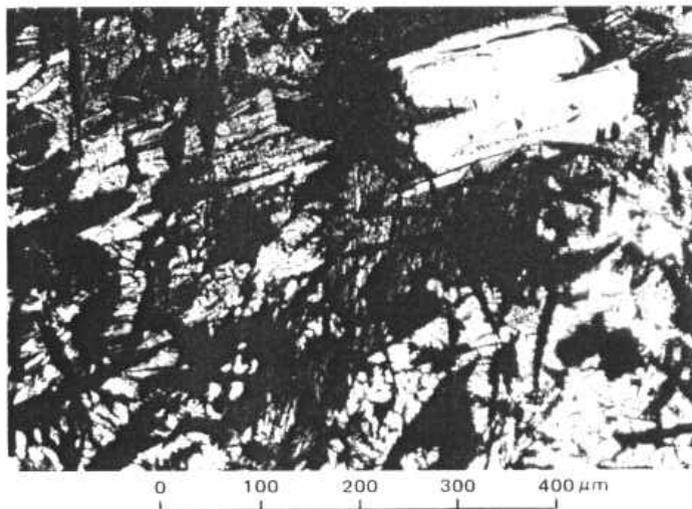


FIGURE 124.-Sample 74235. Photomicrograph showing quenched olivine in variolitic groundmass of ilmenite, clinopyroxene, and plagioclase.

granular groundmass of plagioclase, pyroxene, ilmenite, and accessory minerals.

Major-element composition:

Chemical analyses of 74275				
	1	2	3	4
SiO <sub>2</sub> .....	38.43	38.7	38.44	38.5
Al <sub>2</sub> O <sub>3</sub> .....	8.51	8.39	8.93	8.61
FeO.....	18.25	18.24	18.03	18.17
MgO.....	10.26	10.15	10.46	10.29
CaO.....	10.38	10.1	10.26	10.2
Na <sub>2</sub> O.....	.37	.370	.33	.36
K <sub>2</sub> O.....	.075	.080	.09	.08
TiO <sub>2</sub> .....	12.66	11.84	12.75	12.42
P <sub>2</sub> O <sub>5</sub> .....	.074	.063	.06	.07
MnO.....	.247	.241	.27	.25
Cr <sub>2</sub> O <sub>3</sub> .....	.639	.539	.65	.61
Total	99.895	98.713	100.27	99.56

1. 74275.58 (Rose and others, 1974).
2. 74275.69 (Duncan and others, 1974).
3. 74275.98 (Rhodes and others, 1975).
4. Average of 1 through 3.

Age: Rb-Sr isochron: 74725,56, 3.81 ±0.32 b.y. (Nyquist and others, 1976).

Exposure age: Kr: 74275,24, 32± 1 m.y. (Eberhardt and others, 1975).

STATION LRV-7

LOCATION

Station LRV-7 is located on the south rim of the Victory crater cluster approximately 1.3 km east of Shorty crater and station 4 (fig. 7C).

OBJECTIVES

The stop at Victory was planned to collect a regolith

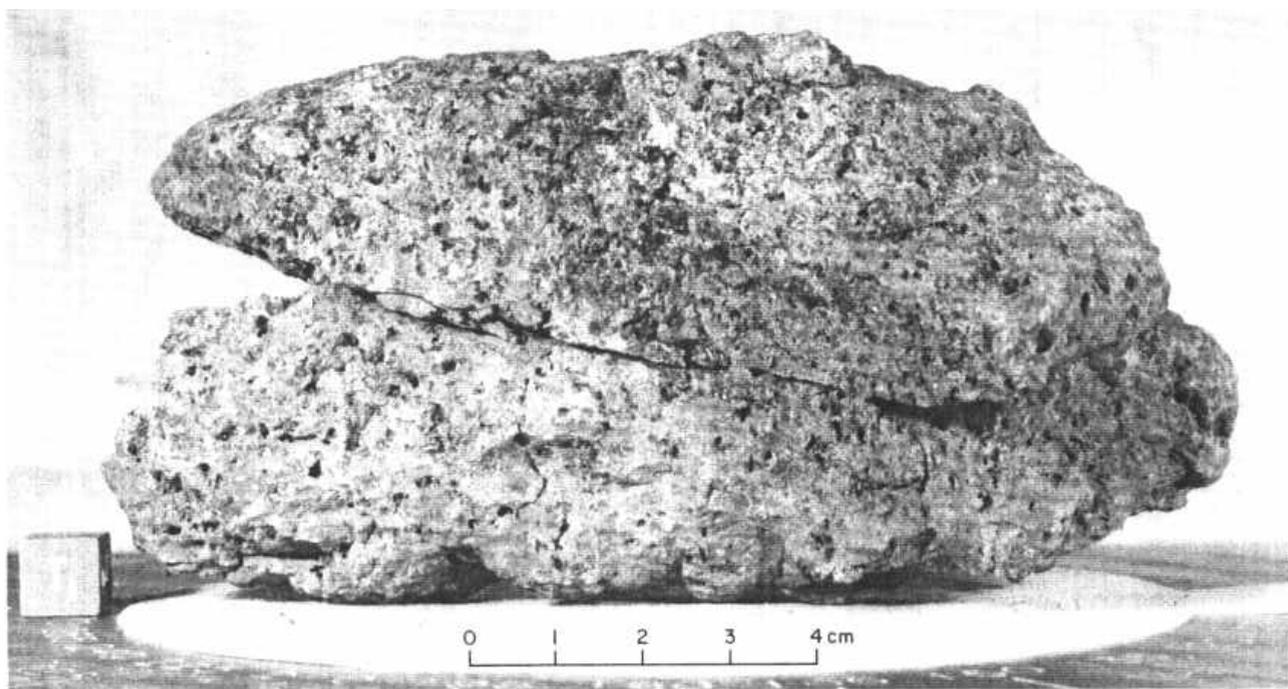


FIGURE 125.-Sample 74255. Medium-grained vesicular olivine basalt. (NASA photograph S-73-16904.)

sample, take a photographic panorama front the LRV, place and explosive package number 1 on the surface.

GENERAL OBSERVATIONS

The station area is on the gently sloping rim crest (fig. 128) of Victory crater. Scattered subdued craters in the sampling area range in size from 1 to 5 m. Blocks

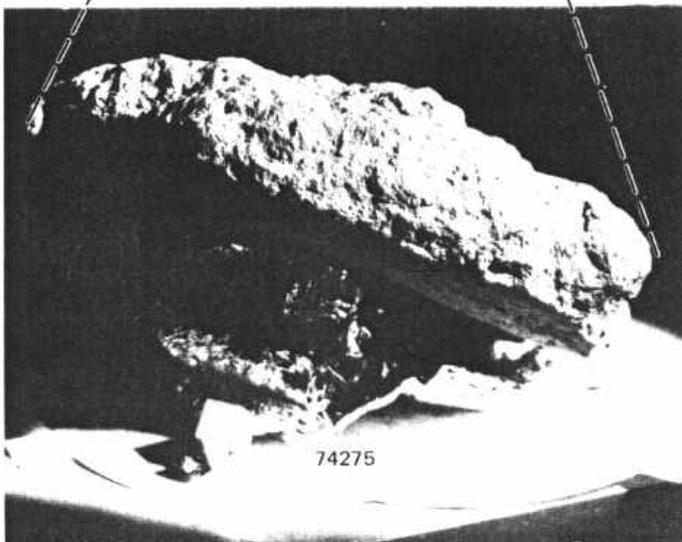
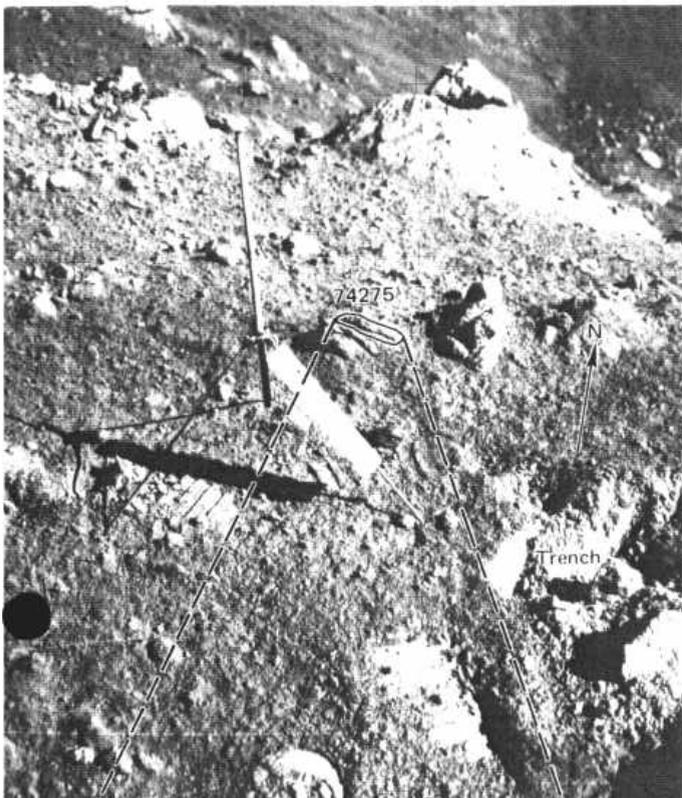


FIGURE 126.-Top, sample 74275 before collection (NASA photograph AS17-137-20984) and, bottom, reconstructed lunar surface orientation and lighting (NASA photograph S- 73-18405).

up to 1 m in diameter cover 2 to 3 percent of the surface. The blocks are slightly to moderately buried, and fillets are rare. A sediment sample was collected.

SUMMARY OF SAMPLING

Sample 75110-15

Type: Sedimentary, unconsolidated (75110-14) and basalt (75115).

Size: 75115, 2x1.3x1 cm.

Weight: 75110-14, 381.33 g; 75115, 2.60 g.

Depth: From upper few centimeters.

Location: South rim crest of Victory crater.

Illustration : Figure 128.

Petrographic description: 75110-14, dominantly basalt, some fine-grained breccia and (or) metaclastic rock, minor agglutinate.

Components of 90-150-um fraction of 75111,13 (Heiken and McKay, 1974)

Components	Volume Percent
Agglutinate.....	52.2
Basalt, equigranular.....	5.6
Basalt, variolitic.....	2.7
Breccia:	
Low grade <sup>1</sup> - brown.....	2.3
Low grade <sup>1</sup> - colorless.....	--
Medium to high grade <sup>2</sup> .....	5.6
Anorthosite.....	--
Cataclastic anorthosite <sup>3</sup> .....	.7
Norite.....	--
Gabbro.....	--
Plagioclase.....	2.0
Clinopyroxene.....	8.3
Orthopyroxene.....	--
Olivine.....	--
Ilmenite.....	.7
Glass:	
Orange.....	5.0
"Black".....	11.6
Colorless.....	1.0
Brown.....	1.0

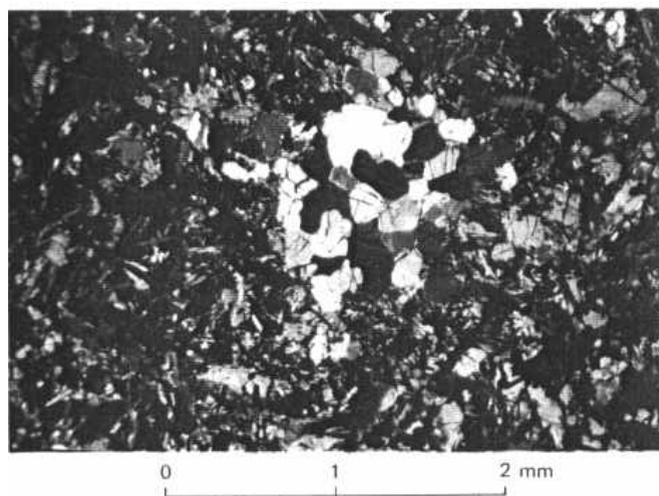


FIGURE 127.-Sample 74275. Photomicrograph showing small "dunitic" in intergranular groundmass of plagioclase, ilmenite, and clinopyroxene. Crossed polarizers.

*Components of 90-150-um fraction of 75111,13 (Heiken and McKav,1974)-Continued*

Components	Volume Percent
Glass:	
Gray, "ropy".....	1.0
Other.....	.3
<hr/>	
Total number of grains.....	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

*Major-element composition:*

*Chemical analyses of 75115*

SiO <sub>2</sub> .....	--
Al <sub>2</sub> O <sub>3</sub> .....	8.9
FeO.....	20.9
MgO.....	9.3
CaO.....	10.5
Na <sub>2</sub> O.....	.386
K <sub>2</sub> O.....	.069
TiO <sub>2</sub> .....	12.6
P <sub>2</sub> O <sub>5</sub> .....	--
MnO.....	.250
Cr <sub>2</sub> O <sub>3</sub> .....	.444

75115,1, 1 (Warner and others, 1975a).

**STATION LRV-8**

LOCATION

Station LRV-8 is located between Victory and Horatio craters approximately 0.7 km east-southeast of station LRV-7 (fig. 7C).

OBJECTIVES

Station LRV-8 was a planned LRV stop to collect a surface sample and to take photographs.

GENERAL OBSERVATIONS

The station area is on a flat to gently rolling area of the valley floor west of the major concentration of fresh clustered craters. Scattered subdued craters range from 1 to 5 m in size. At least three small craters with cloddy ejecta blankets are near the site.

The surface (fig. 129) generally resembles that at LRV stops 1, 3, and 7. Distinguishable fragments cover less than one percent of the surface; in the sample area

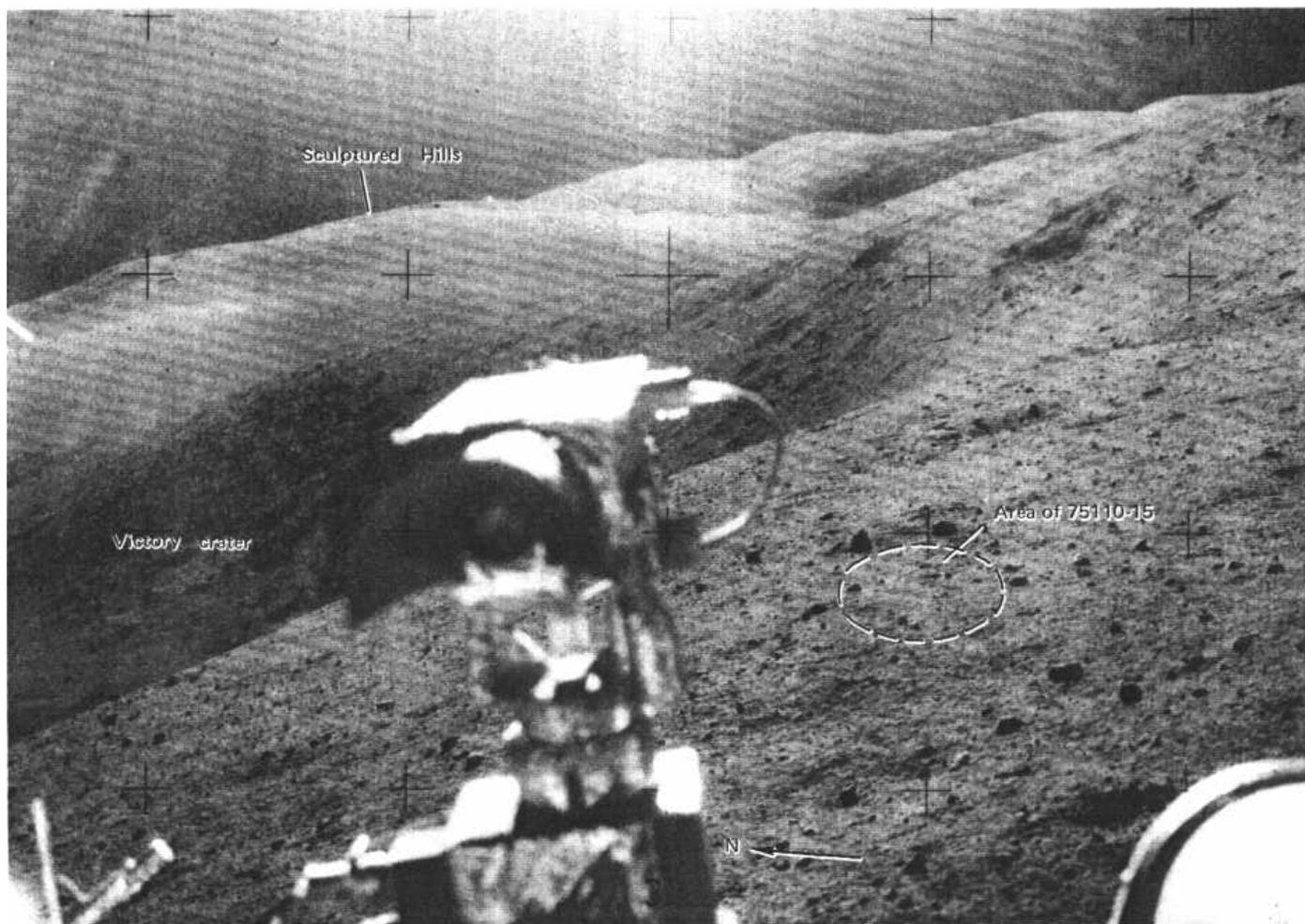


FIGURE 128.-Station LRV-7 area and probable location of sample 75110-15 collection site. (NASA photograph AS17-133-20281.)